E7.6-10272

NASA CR-
147464

SIGNATURE EXTENSION FOR SUN ANGLE

VOLUME I

J. A. Smith,
J. K. Berry,
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Final Report
Earth Observations Division
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(E76-10272) SIGNATURE EXTENSION FOR SUN ANGLE, VOLUME 1 Final Report, 15 Nov. 1974 - 14 Nov. 1975 (Colorado State Univ.) 111 p HC $5.00 CSCL 03B

N76-21639

Unclas
G3/43 00272

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ABSTRACT

This is the first volume in a two-volume final report series for Project NAS 9-14467 sponsored by the Earth Observations Division, NASA/JSC. This report series summarizes the work covered between the period November 15, 1974, and November 14, 1975. The objectives of the project were to evaluate the LACIE II table look-up approach to sun-angle correction. Canopy reflectance modeling was employed as a technique for evaluating sun-angle signature extension.

Volume I presents the multiplicative and additive coefficient matrices for a linear sun-angle correction approach. These coefficient tables are calculated using either measured empirical canopy reflectance functions or model derived data. These values are then incorporated into an atmospheric radiation transfer model. The dependence of the coefficient matrices on crop stage, crop type, and canopy directional reflectance variations is reviewed. Finally, a method for inferring leaf area index, an intrinsic scene characteristic, from canopy reflectance is discussed.

Volume II presents the basic data and computer programs used in the study. A brief review of the radiometric and geometric data collection procedures is also given. In particular, two recent methods developed by the investigators for determining plant geometry are discussed. These include the Fourier diffraction and multiple view angle approach. The data compilation consists of canopy reflectance, constituent reflectance, Leaf-Area-Indices, and leaf slope distributions for four wheat crop development stages at Garden City, Kansas.

FOREWORD

The research described in this report was supported under contract NAS9-14467, issued by the National Aeronautics and Space Administration, Earth Observations Division, Johnson Spacecraft Center, Houston, Texas. Mr. T. Barnett was the technical monitor of the project. The efforts described in this report represent Task 4.1.1.2 f(S) described in LACIE 00200, Volume III. Field data for the project were gathered over the LACIE Intensive Test Sites in Garden City, Kansas. The measurements were performed in cooperation with Dr. J. C. Harlan, Remote Sensing Center, Texas A & M University. Mr. Barrett Robinson, Laboratories for Applications of Remote Sensing, Purdue University, constructed the diffuse radiometer attachment for measuring leaf transmittance.

Participating project personnel included Dr. James A. Smith, Department of Earth Resources and Principal Investigator; Mr. Joe Berry, Graduate Research Assistant, and Mr. Rick Heimes, Graduate Research Assistant. Other project personnel included Miss Carol Conrad and Mrs. Pam Solomon, Colorado State University, who assisted in preparing the final report. Mr. Berry received the degree, Doctor of Philosophy, for work related to project sub-tasks.

The authors would particularly like to express their appreciation to Dr. Harlan and his research team for their field measurement support and to Dr. A. E. Potter, Chief of the Research, Test, and Evaluation Branch, Earth Observations Division, under whose auspices this work was performed.

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I. INTRODUCTION

This is the first volume in a two-volume final report for NAS 9-14467 which represents Task 4.1.1.2f(s) in the LACIE 00200, Volume VIII. Specific objectives of this task in order of priority include:

A. To evaluate the current LACIE II table look-up sun angle correction algorithms relative to:
   1. The effect of canopy reflectance variations with sun angle;
   2. The effect of canopy sun angle reflectance variations with crop development stages;
   3. The effect of applying a uniform sun angle correction developed specifically for wheat to all crop types.

B. To recommend modifications to the current LACIE II sun angle correction algorithm.

C. To investigate alternative sun angle correction procedures for present and future satellite systems. In particular, to investigate the possibility of extracting intrinsic scene characteristics from wheat canopy modeling.

The current LACIE II sun-angle correction algorithm is based on the fundamental assumption that the radiance detected by LANDSAT at one sun angle, θ_i, is linearly related to the radiance detected at another sun angle, θ_j.

That is, for each MSS band:

$$N_{\theta_i} = \alpha_{\theta_i\theta_j} N_{\theta_i} + \beta_{\theta_i\theta_j}$$

Consequently, the mean vector and covariance matrix determined from one training segment at sun angle θ_i may be adjusted for data collected at a

second sun angle θ_j, by matrix transformation of the training statistics. This is accomplished by employing a diagonal matrix of alpha coefficients, $\underline{A}$, and a diagonal matrix of Beta coefficients, $\underline{B}$, as discussed in Section II. In practice, the algorithm consists of calculating appropriate tables of alpha and beta coefficients for each multi-spectral band at five degree increments. These coefficient matrices are calculated using the Turner atmospheric radiation model (Turner, 1973) for those sets of sun angles available from the field collected data and for all sun angles using SRVC canopy reflectance model data (Oliver and Smith, 1974). Tables for each crop development stage are calculated using both Lambertian and directional reflectance properties of the canopy. The effects of changes in canopy reflectance resulting from crop type variations are also discussed.

Section III reviews the use of the SRVC canopy reflectance model to generate wheat canopy reflectance curves as a function of sun angle crop stage. The model is calibrated and compared with field data. Section IV summarizes some predictive relationships relating leaf area index, an intrinsic geometric parameter of the canopy, and canopy reflectance. Conclusions and recommendations are given in Section V.

Volume II of this final report series includes a description of field data collection techniques; a complete listing of the radiometric and geometric data, and computer program listings and descriptions that were employed in this study.

The techniques developed for measuring plant geometry and the data compilation for the test sites at Garden City, Kansas, for each of four crop development stages should be of particular and general interest.

II. SUN-ANGLE SIGNATURE EXTENSION

This section describes the procedure used in developing the multiplicative and additive coefficients of the linear correction algorithm for sun-angle effects. Figure 1 summarizes the interactions affecting the recorded radiance (LT) at the satellite sensor. In mathematical terms,

$$\begin{aligned} LT_{i\lambda} &= \frac{\rho_{i\lambda}\,\tau_{i\lambda}}{\pi}\left(H_{SUN}\cos\theta + H_{SKY}\right) + LP_{i\lambda} \\ &= \frac{\rho_{i\lambda}\,\tau_{i\lambda}\,H_{i\lambda}}{\pi} + LP_{i\lambda} \\ &= L_{i\lambda} + LP_{i\lambda} \end{aligned}$$

where, i = solar zenith angle

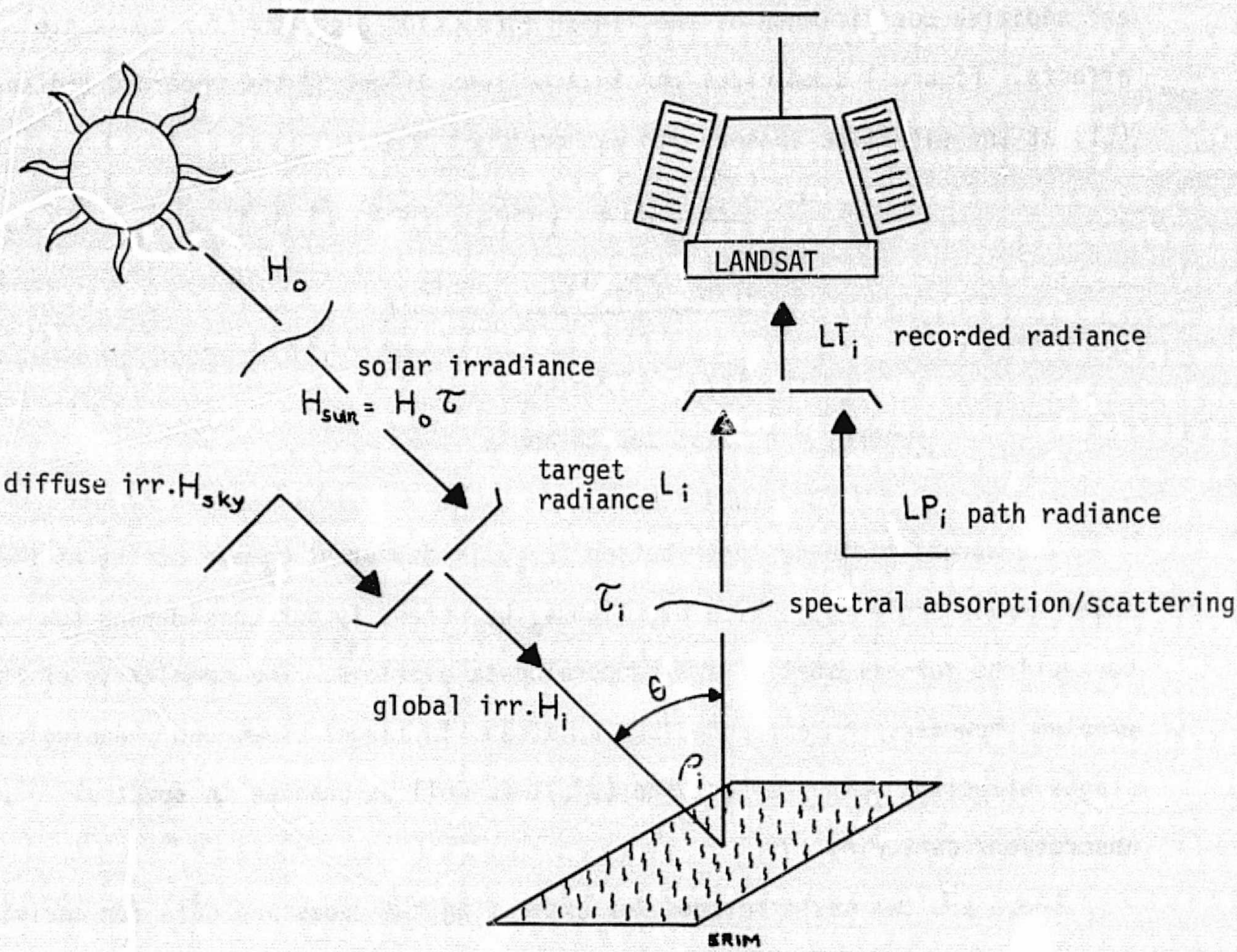
λ = wavelength

The target radiance contribution ($L_{i\lambda}$) is dependent on the cosine of the solar zenith angle (θ), which highlights the necessity for considering sun angle corrections for all spatial and temporal data overlays. The complexity of this problem, however, is compounded by variations in target types and phenological stages affecting scene reflectance ($\rho_{i\lambda}$), as well as changes in spectral absorption/scattering ($\tau_{i\lambda}$).

There are two basic methods for extracting the necessary data for deriving sun angle correction algorithms -- empirical study and modeling. Both of these appraoches are presented in this report. Colorado State University's Solar Radiation-Vegetation Canopy (SRVC) model is used in the modeling approach. The plant canopy model generates surface reflectance values ($\rho_{i\lambda}$) for varying sun angles, given certain intrinsic scene parameters (e.g., LAI, leaf angle distribution, consistent ρ and τ). These reflectance predictions act as input to an atmospheric model yielding target radiance, path radiance and total recorded radiance. This information can then be analyzed to identify the sun angle relationship.

The LACIE project currently assumes a linear correction model as follows:

$$LT_2 = \alpha_{1,2} LT_1 + \beta_{1,2}$$



recorded radiance
=(global irradiance * target reflectance * spectral absorption/scattering
+ path radiance)
=target radiance + path radiance

FIGURE 1. The Interactions of Solar Radiation

An estimate for α and β that is often employed when θ_1 and θ_2 are nearly the same is,

$$\alpha_{1,2} = \cos\theta_2 / \cos\theta_1$$

$$\beta_{1,2} = 0.$$

It appears that this correction is sufficient when θ_1 and θ_2 are nearly the same.

A more rigorous estimate of the α and β coefficients may be derived by the following procedure.

1. The equations for two different sun angles are:

$$LT_1 = \frac{H_1 \rho_1 \tau_1}{\pi} + LP_1 \qquad \text{eq. 1}$$

$$LT_2 = \frac{H_2 \rho_2 \tau_2}{\pi} + LP_2 \qquad \text{eq. 2}$$

$$\text{where; } \frac{H_i \rho_i \tau_i}{\pi} = L_i$$

2. Simultaneous solution of the two equations:

$$LT_1\left[\frac{H_2\rho_2\tau_2}{H_1\rho_1\tau_1}\right] = \frac{H_2\rho_2\tau_2}{\pi} + LP_1\left[\frac{H_2\rho_2\tau_2}{H_1\rho_1\tau_1}\right] \qquad \text{eq. 1 multiplied by } \left[\frac{H_2\rho_2\tau_2}{H_1\rho_1\tau_1}\right]$$

$$LT_2 - LT_1\left[\frac{H_2\rho_2\tau_2}{H_1\rho_1\tau_1}\right] = LP_1 - LP_2\left[\frac{H_2\rho_2\tau_2}{H_1\rho_1\tau_1}\right] \qquad \text{subtract new eq. 1 from eq. 2}$$

$$LT_2 = LT_1\left[\frac{H_2\rho_2\tau_2}{H_1\rho_1\tau_1}\right] + \left[LP_2 - LP_1\left(\frac{H_2\rho_2\tau_2}{H_1\rho_1\tau_1}\right)\right] \qquad \text{rearrange terms}$$

3. With the final solution form:

$$LT_2 = LT_1\,\alpha_{1,2} + LP_2 - LP_1\,\alpha_{1,2}$$

$$= LT_1\,\alpha_{1,2} + \beta_{1,2}$$

$$\text{where; } \alpha_{1,2} = \frac{H_2\rho_2\tau_2}{H_1\rho_1\tau_1}$$

$$\beta_{1,2} = LP_2 - LP_1\left(\frac{H_2\rho_2\tau_2}{H_1\rho_1\tau_1}\right)$$

4. These coefficients expressed in atmospheric modeling terms are:

$$\alpha_{1,2} = (LT_2 - LP_2)/(LT_1 - LP_1)$$

$$\beta_{1,2} = LP_2 - (LP_1 * \alpha_{1,2})$$

5. By varying the input parameters of the SRVC model, temporal, spatial and crop type changes can be induced and the resultant target reflectance monitored. This reflectance variable is then used as input to an atmospheric model which solves for path radiance, target radiance and recorded radiance. Utilizing the equations cited in item 4, a complete set of tables of α and β

coefficients can be developed for specific scene characteristics and atmospheric conditions.

The following sections are concerned with three primary topics: 1) the calculation of α and β coefficients from field measured data; 2) the calculation of α and β coefficients from model derived data; and 3) an investigation as to possible sources of variation in the sun-angle correction procedure under study.

1.0 Correction Coefficient Matrices Calculated from Empirical Data.

Table 1 summarizes the solar angles coincident with field radiometer measurements for four phenological stages of wheat at the LACIE Intensive Site, Finney County, Kansas. A detailed discussion of the data collection procedures employed and a presentation of the data is made in Volume II of this report. This data set served as a foundation in deriving the empirically based correction coefficients.

Two fundamentally different approaches were used, which yielded two different types of coefficients. One approach determined the overall average canopy reflectance by calculating the mean reflectance for each LANDSAT band without regard to sun-angle or leaf area index variations. This method implies that the plant canopy acts as a Lambertian surface, and that all sun-angle effects are induced by atmospheric variables.

The second approach maintains sun-angle continuity by calculating a mean reflectance in each band for all plots having the same sun position at the time of measurement. This approach assumes that plant canopies display significant bi-directional reflectance. Canopy effects then combine with atmospheric effects to yield the overall sun-angle variations in sensor signals. Appendix B contains plots of the empirical data used in both approaches and Appendix C.1 presents the actual data.

For the Type I empirical coefficients (Lambertian), the Turner Atmospheric Model was executed using the grand mean reflectance for each sun-angle envelope

TABLE 1

SUN ANGLES
(Degree Zenith)
Occurring During Radiometric
Data Collection

TIME (LOCAL)	MARCH 20	APRIL 23	MAY 20	JUNE 26
0930	-	-	57°	-
1000	-	55°	51°	48°
1030	57°	49°	45°	42°
1100	52°	44°	40°	37°
1130	47°	39°	34°	31°
1200	44°	34°	29°	26°
1230	41°	30°	24°	21°
1300	39°	27°	20°	17°
1330	38°	25°	18°	15°
1400	39°	25°	18°	-
1430	40°	27°	-	-
1500	43°	31°	-	-
1530	47°	35°	-	-
1600	51°	40°	-	-
1630	56°	45°	-	-
1700	-	51°	-	-
1730	-	56°	-	-
1800	-	62°	-	-

indicated in Table 1. The Type II procedure involved executing the Turner model with the same sun-angle envelopes as with Type I, however, each sun-angle was matched with an empirical canopy reflectance corresponding to that sun-angle. The output in each case is a prediction of the path, target and total radiance at a satellite sensor under nominal conditions. These variables were used to solve for the individual α and β coefficients as described in the previous section. Appendix A.1.0 presents the Type I empirical coefficient matrices, while A.2.0 presents the Type II coefficients.

2.0 Correction Coefficient Matrices Calculated from Model Derived Data

A detailed discussion of the canopy model simulation procedure is presented in Section III of this volume. In brief, it employs Colorado State University's SRVC model to predict a plant canopy's spectral reflectance, based on descriptive intrinsic and environmental variables. In simulating sun angle effects, the model's variables were fixed in accordance with field measurements, while the sun's position was varied from 5° to 70° (zenith). The result of this effort is a model derived data set similar to the empirical Type II (directional) data set discussed in the previous section. Appendix C.2 contains the model generated canopy reflectances as a function of sun angle for each phenology stage. The Turner model predictions of sensor radiance for the model reflectances were generated in the same manner as the Type II predictions. The α and β coefficient matrices are presented in Appendix A.3.0.

Figure 2 and Table 2 identify a terse comparison of corrected and uncorrected signatures for the April field data using the model derived correction coefficients. The procedure of the comparison involved using the Turner model to convert field reflectance measurements taken at different sun angles into radiance values. These data are shown in the left graph. The signatures were then corrected for sun angle variation using the 47° solar zenith angle signature as the correction base. The right hand graph shows the corrected data

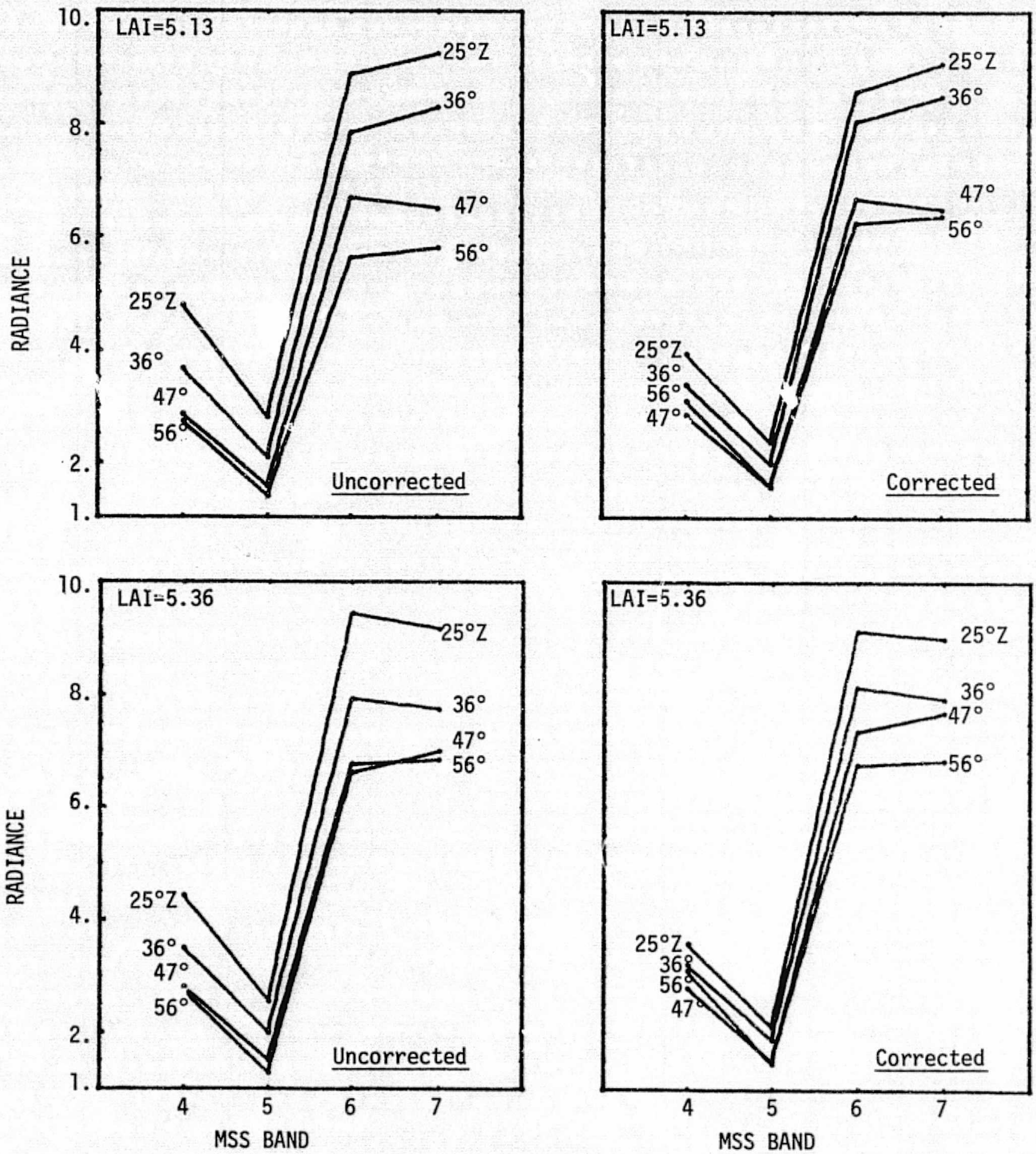


FIGURE 2. Comparison of uncorrected and sun-angle corrected signatures for April field data (47° solar zenith angle used as correction base)

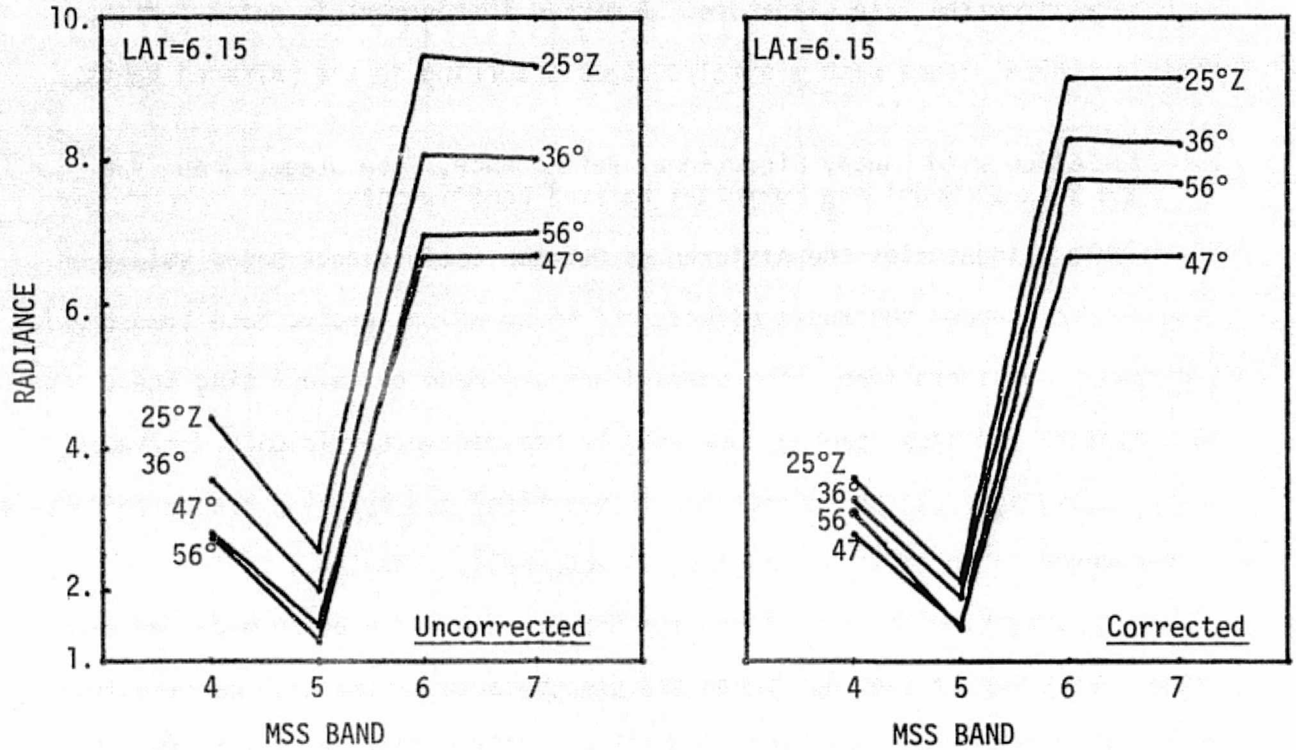


FIGURE 2. Continued

TABLE 3
MEAN SQUARED DEVIATION IN
SENSOR RESPONSE FROM BASE
SIGNATURE (47° SOLAR ZENITH ANGLE)

LAI	SUN ANGLE	MSS4	MSS4 CORR	MSS5	MSS5 CORR	MSS6	MSS6 CORR	MSS7	MSS7 CORR
5.13	25°Z	3.767	1.184	1.538	.646	4.827	3.602	7.557	6.693
	35	.654	.291	.264	.175	1.329	1.866	3.211	4.000
	55	.017	.063	.032	.001	1.115	.177	.479	.013
5.36	25	2.647	.616	1.071	.365	7.140	5.607	5.392	4.666
	35	.477	.172	.230	.144	1.336	1.885	.799	1.179
	55	.006	.091	.051	.002	.024	.349	.023	.717
6.15	25	2.634	.608	1.111	.388	7.862	6.245	6.975	6.140
	35	.558	.225	.247	.158	2.002	2.683	1.812	2.393
	55	.005	.099	.051	.002	.086	1.160	.101	1.020
Mean Squared Error		1.20	.37	.511	.209	2.858	2.619	2.928	2.980

in which a compression of the extended signatures about the 47° signature is apparent. Table 2 summarizes the mean squared deviations of the extended signatures from the base signature. A marked improvement is noted for the visible LANDSAT bands with minimal success occurring in the infrared bands.

3.0 Variation with Canopy Directional Reflectance, Crop Stage, Crop Type and Between Model and Empirical Derived Coefficients

Table 3 identifies the differences between coefficients based solely on atmospheric induced sun angle effects and those which involve both atmospheric and canopy considerations. The comparisons are made by calculating the change in a typical radiance reading corrected by empirical coefficients derived by using an averaged canopy reflectance (Lambertian) and by using canopy reflectance values keyed to specific sun angles (directional). The table is organized by phenology stages, with comparisons for MSS bands 4 and 6 being made for each stage. Only two of the four bands are used because of the high correlation within the visible and near infrared bands. Differences are slight for the most part. It is hypothesized that the slight differences exhibited are a result of the fact that sun angles between 35 and 50 degrees tend to fall in the flat position of the reflectance curves for these wavelengths. To see if the hypothesis was correct, a difference was evaluated for the month of April from 35 to 60° sun angle, band 6, because this reflectance curve increases sharply between 55 and 60°. The result was that the difference between Lambertian and directional corrected values increased from a negligible percentage between 35 - 50° sun angle to a difference of -21% between 35 - 60° sun angle. The difference between Lambertian and directional corrected values was 19% between 55 - 60° sun angle where the reflectance curve changed dramatically.

TABLE 3

COMPARISON OF LAMBERTIAN AND DIRECTIONAL EMPIRICAL COEFFICIENTS

MARCH

BAND 4

	40	45	50
35	-.02	-.04	-.05
40		-.01	-.03
45			-.02

BAND 6

	40	45	50
35	-.05	-.09	-.12
40		-.03	-.08
45			-.03

APRIL

BAND 4

	40	45	50
35	.03	.04	.04
40		.03	.02
45			.00

BAND 6

	40	45	50	60
35	.00	.01	.01	-.21
40		.00	.00	
45			.00	

MAY

BAND 4

	40	45	50
35	.02	.04	.06
40		.02	.05
45			.02

BAND 6

	40	45	50
35	.02	.04	.06
40		.02	.03
45			.03

JUNE

BAND 4

	40	45	50
35	.03	.05	.08
40		.04	.05
45			.01

BAND 6

	40	45	50
35	.02	.02	.04
40		.01	.01
45			.02

It was further noted that when the reflectance curve declined as sun angle increased the differences between Lambertian and directional were positive percentages becoming larger with steeper slopes of the reflectance curves. Negative percent differences were exhibited when reflectance curves increased with increasing sun angle.

Table 4 considers the changes in corrected radiance readings induced by crop development. The change is reported in reference to the empirical directional coefficients for the March phenology stage (i.e., (March - X)/March). Comparisons are made for both a visible and near infrared band.

The percent changes between March and each of the other three months vary from 3% to 16% with a mean of about 8%. However, differences between the month of April, May and June are very slight. The sun angles used in this evaluation, 35-50 degrees, are in the flat portion of the refelctance curves for each month and each of the two wavelengths. The reflectance increases with increasing sun angle over the 35°-50° range during March and decreases with increasing sun angle over the 35°-50° range during the other three months. This trend holds true for both wavelengths, being somewhat more pronounced in band 7 than in band 5. This change in slope of the reflectance curves between March and each of the other three months over sun angles between 35°-50° (Appendix B) explains the larger differences in correction coefficients between March and other months. The slope of the reflectance curves for April, May and June, between 35-50° sun angle, vary only slightly from one to the other. This accounts for the slight differences in correction coefficients between April, May and June.

A comparison of the model and empirical derived correction coefficients is presented in Table 5. Both the empirical and model data sets used to derive the coefficients treated the canopy as having bi-direction reflectance. The tabular values represent the change in corrected radiance readings calculated by the two techniques. The empirical based corrections are used as reference (i.e., (empirical-model)/empirical).

TABLE 4

PHENOLOGICALLY INCITED DIFFERENCES IN DIRECTIONAL EMPIRICAL COEFFICIENTS

MARCH-APRIL

BAND 4

	40	45	50
35	.05	.09	.09
40		.05	.06
45			.09

BAND 6

	40	45	50
35	.05	.09	.12
40		.03	.07
45			.03

MARCH-MAY

BAND 4

	40	45	50
35	.05	.09	.12
40		.04	.08
45			.12

BAND 6

	40	45	50
35	.07	.12	.16
40		.05	.10
45			.06

MARCH-JUNE

BAND 4

	40	45	50
35	.05	.08	.11
40		.04	.07
45			.10

BAND 6

	40	45	50
35	.07	.10	.14
40		.04	.08
45			.05

TABLE 5

COMPARISON OF DIRECTIONAL EMPIRICAL AND MODEL CORRECTION COEFFICIENTS

BAND 4 | BAND 6

MARCH

Band 4:

	40	45	50
35	-.00	-.02	-.02
40		-.01	-.01
45			.00

Band 6:

	40	45	50
35	-.02	-.04	-.08
40		-.03	-.05
45			-.04

APRIL

Band 4:

	40	45	50
35	-.08	0.14	-.15
40		-.07	-.08
45			-.01

Band 6:

	40	45	50
35	-.10	-.22	-.25
40		-.09	-.14
45			-.03

MAY

Band 4:

	40	45	50
35	-.04	-.09	-.16
40		-.04	-.13
45			-.08

Band 6:

	40	45	50
35	-.08	-.17	-.30
40		-.07	-.21
45			-.14

JUNE

Band 4:

	40	45	50
35	-.09	-.19	-.31
40		-.10	-.21
45			-.10

Band 6:

	40	45	50
35	-.15	-.25	-.40
40		-.10	-.22
45			-.12

The best agreement between the two approaches occurs for the March data, while the worst occurs in June. The overall comparison, however, notes an average difference of about 12%. The extremely large discrepancies in the June data are most likely a result of the insufficient radiometric data collected during this period.

The effects of crop type variations on correction coefficients were simulated by varying both the optical parameters of a canopy, i.e., the leaf reflectance/transmittance, and the leaf slope distribution. For this study, leaf reflectance values for barley and bean were selected from a field study by the USDA-ARS at Weslaco, Texas, (Gausman, 1971). To incorporate geometry effects, the leaf slope distribution for wheat was reversed, i.e., the probability density $p(\cos\theta)$ was changed to $p(\cos\theta_i) = p(\cos(90-\theta_i))$.

Table 6 gives the calculated alpha and beta coefficients for the wheat, barley, bean, and "inverse" cases described above for MSS 4 and MSS 6. Three sun-angle combinations were employed, (10,35), (35,40), and (40,65) representing three different angle extension cases; two large sun angle extensions and a small range near median sun angles.

Table 7 summarizes the differences between each case compared to wheat as a reference. The linear correction coefficients in Table 6 were applied for typically occurring radiance values of 3.5 for MSS 4 and a value of 6.5 for MSS 6. In general, differences are slight in the visible band except for wheat/barley differences at low sun angles (high zenith values) where the canopy exhibits large non-Lambertian effects. However, differences of at least 10 percent are exhibited in the infrared band, MSS 6, at all sun angles for wheat/barley.

TABLE 6. Alpha and Beta Coefficient Matrices for Simulation Crop Type Study.

	Alpha Values			Beta Values		
MSS4	(10,35)	(35,40)	(40,65)	(10,35)	(35,40)	(40,65)
Wheat	1.03	1.04	0.80	-1.82	-0.26	-0.16
Barley	0.82	0.93	0.52	-1.04	-0.05	0.34
Bean	1.04	1.04	0.80	-1.85	-0.27	-0.16
Inverse	0.98	0.97	0.72	-1.64	-0.13	-0.02

	Alpha Values			Beta Values		
MSS6	(10,35)	(35,40)	(40,65)	(10,35)	(35,40)	(40,65)
Wheat	1.06	1.03	0.85	-0.43	-0.07	-0.06
Barley	0.83	0.93	0.54	-0.22	-0.01	0.10
Bean	1.07	1.04	0.84	-0.43	-0.07	-0.05
Inverse	0.99	0.98	0.76	-0.36	-0.04	-0.01

TABLE 7. Comparison of Crop Type Variations Effects on Correction Coefficients

	Band 4			Band 6		
	(10,35)	(35,40)	(40,65	(10,35)	(35,40)	(40,65)
Wheat-Barley	-.02	.05	.18	.20	.09	.34
Wheat-Bean	-.00	.00	.00	-.01	-.01	.01
Wheat-Inverse	-.00	.03	.05	.06	.04	.10

III. SIMULATION ANALYSIS

This section describes the modeling effort associated with the project's primary task of deriving sun angle correction techniques (Section II). It consists of two subsections: 1) a general comparison of model and empirical broad-band signatures for each phenological stage; and 2) a detailed presentation of sun angle induced variations in reflectance, for each phenological stage, as determined by both field measurement and vegetation canopy modeling. Each subsection consists of a tabular and graphical summary of the applicable data and a brief discussion of the more important aspects.

The model canopy reflectance predictions were made by Colorado State University's SRVC model which is described in detail in Volume II, Section IV.1. Basically, the model utilizes Monte Carlo techniques to trace the interaction of scene irradiance with the plant canopy, and estimate the resulting characteristic reflectance. The principle scene and environmental variables incorporated in the model, include leaf area index, leaf angle distribution, individual leaf transmission and reflectance, soil reflectance, diffuse/direct irradiance ratio sensor position, and sun location. Extensive field data were collected to estimate the intrinsic scene variables and establish an empirical data base in order to evaluate the model's predictions. The field procedures used and resulting data are described in Sections II and III of Volume II. Data were acquired for four phenological stages of wheat at the LACIE Intensive Site, Garden City, Kansas: 1) tillering, 2) jointing, 3) heading, and 4) ripening. In simulating sun angle effects, all of the variables of the canopy model were fixed in accordance with the field estimates, while the sun position was varied from 5° to 70° (zenith). Table 1 identifies the input data for the model at each stage.

TABLE 1

INPUT PARAMETERS FOR SRVC MODEL

SUN ANGLE EFFECTS DATA CREATION - JUNE

DAY	177	YEAR	1975	TIME	0930*		
LAT.	38.	LONG.	101.	DEC.	23.28		
NSAMP	10	NTRIAL	5	NLAY	1	NCONST	1

LAD (0-90°;5° incr.)			0.	0.	.017	.009	.003	0.
.001	.005	.011	.017	.026	.046	.075	.099	.124
.147	.159	.143	.081					
LAI	5.16							

NWAVE	.55	.65	.75	.95
DIFF./TOTAL IRRADIANCE*	.096	.085	.102	.102
SOIL REFLECTANCE	.173	.191	.259	.309
LEAF REFLECTANCE	.210	.230	.433	.495
LEAF TRANSMITTANCE	.210	.230	.433	.495

SUN ANGLE EFFECTS DATA CREATION - MAY

DAY	140	YEAR	1975	TIME	0939*		
LAT.	38.	LONG.	101.	DEC.	20.03		
NSAMP	10	NTRIAL	5	NLAY	1	NCONST	1

LAD (0-90°; 5° incr.)			0.	.035	.027	.010	.007	.006
.006	.011	.014	.043	.061	.061	.083	.098	.112
.120	.115	.101	.059					
LAI	5.16							

NWAVE	.55	.65	.75	.95
DIFF./TOTAL IRRADIANCE*	.099	.084	.112	.138
SOIL REFLECTANCE	.160	.196	.275	.319
LEAF REFLECTANCE	.071	.050	.369	.495
LEAF TRANSMITTANCE	.071	.050	.369	.495

SUN ANGLE EFFECTS DATA CREATION - APRIL

DAY	112	YEAR	1975	TIME	0930*		
LAT.	38.	LONG.	101.	DEC.	12.93		
NSAMP	10	NTRIAL	5	NLAY	1	NCONST	1

LAD (0-90°; 5° incr.)			.003	.009	.012	.022	.032	.034
.037	.042	.052	.064	.073	.086	.094	.105	.105
.090	.072	.036	.032					
LAI	5.55							

NWAVE	.55	.65	.75	.95
DIFF./TOTAL IRRADIANCE*	.196	.172	.174	.183
SOIL REFLECTANCE	.186	.185	.243	.299
LEAF REFLECTANCE	.071	.050	.369	.495
LEAF TRANSMITTANCE	.071	.050	.369	.495

Table 1
(Continued)

SUN ANGLE EFFECTS DATA CREATION - MARCH

DAY	79	YEAR	1975	TIME	0930*		
LAT.	38.	LONG.	101.	DEC.	-.08		
NSAMP	10	NTRIAL	5	NLAY	1	NCONST	1

LAD (0-90°; 5° incr.)			.031	.032	.030	.033	.034	.034
.034	.035	.041	.050	.056	.065	.073	.081	.085
.082	.078	.065	.061					
LAI	2.48							

NWAVE	.55	.65	.75	.95
DIFF./TOTAL IRRADIANCE*	.109	.091	.102	.121
SOIL REFLECTANCE	.060	.077	.116	.143
LEAF REFLECTANCE	.071	.050	.369	.495
LEAF TRANSMITTANCE	.071	.050	.369	.495

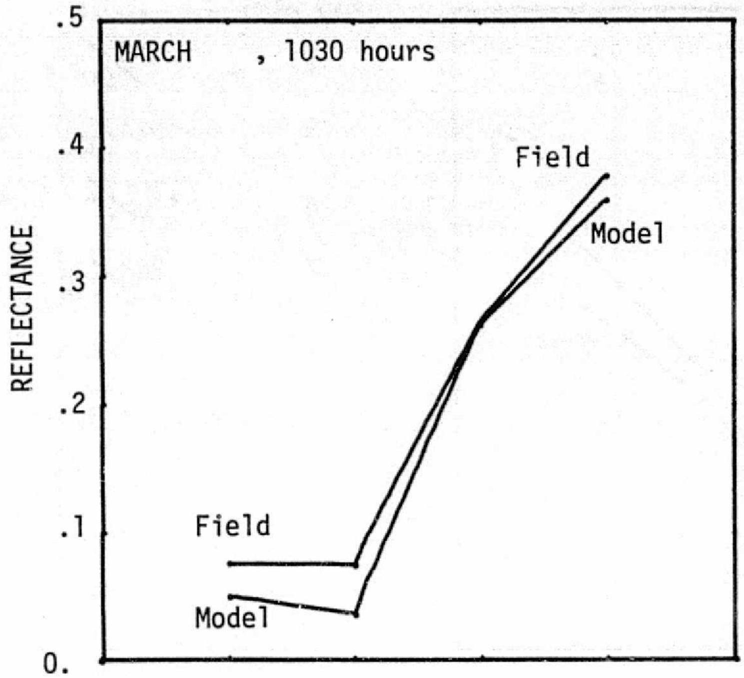
*Value was changed as sun angle effects were simulated.

1.0 Comparison of Model and Field Data

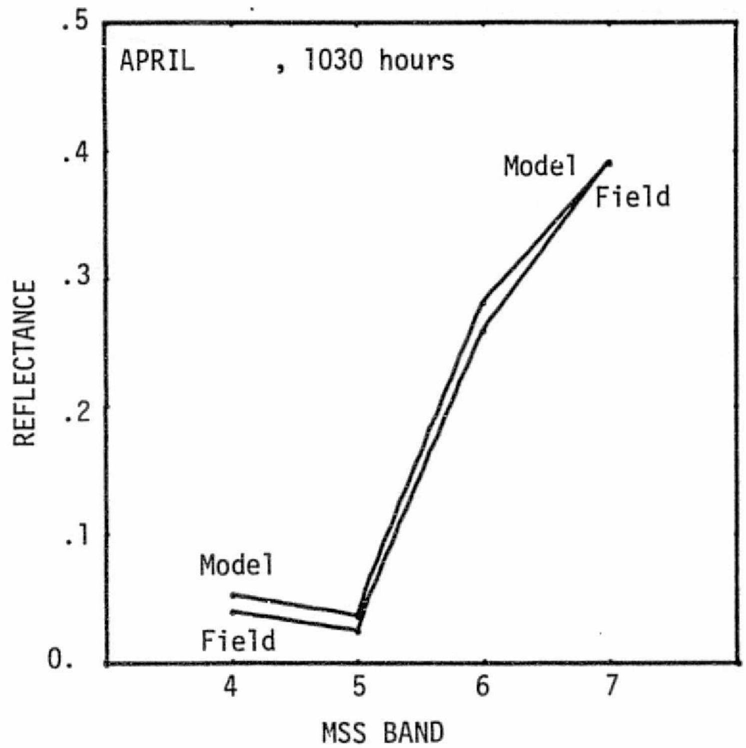
Figures 1 and 2 show a comparison of field and model estimates of canopy reflectance at the four phenological stages of the study. In each case, an attempt was made to approximate the reflectance at time of a LANDSAT overpass. In general, it can be noted that the model was relatively successful in tracking the empirical data during the jointing (April) and heading (May) stages, while it was somewhat less accurate during the tillering (March) and ripening (June) stages. In reviewing this comparison, consideration should be given to the standard deviations for both the model and field values.

The primary sources of error in the March model predictions are most likely a result of the model's inability to adequately deal with the pronounced rowing effect at extremely low LAI's, and the strong contribution of a highly variable soil reflectance. In light of these potential problems, a review of the model is being made to determine the feasibility of making modifications to account for rowing effects. In addition, the field procedures for next year's measurements have been modified to insure a better representation of local soil reflectance.

The discrepancy in the June model and field signatures may be merely a reflection of inadequate empirical data. However, it does appear that the accuracy of individual leaf transmission and reflectance estimates is critical. The dramatic difference between the characteristic signatures of May and June emphasizes the dominant effect of the transition from live to dead leaf reflectance. In order to make better constituent reflectance measurements during the ensuing field season, an attachment for the LANDSAT radiometer is being designed in cooperation with Purdue University.

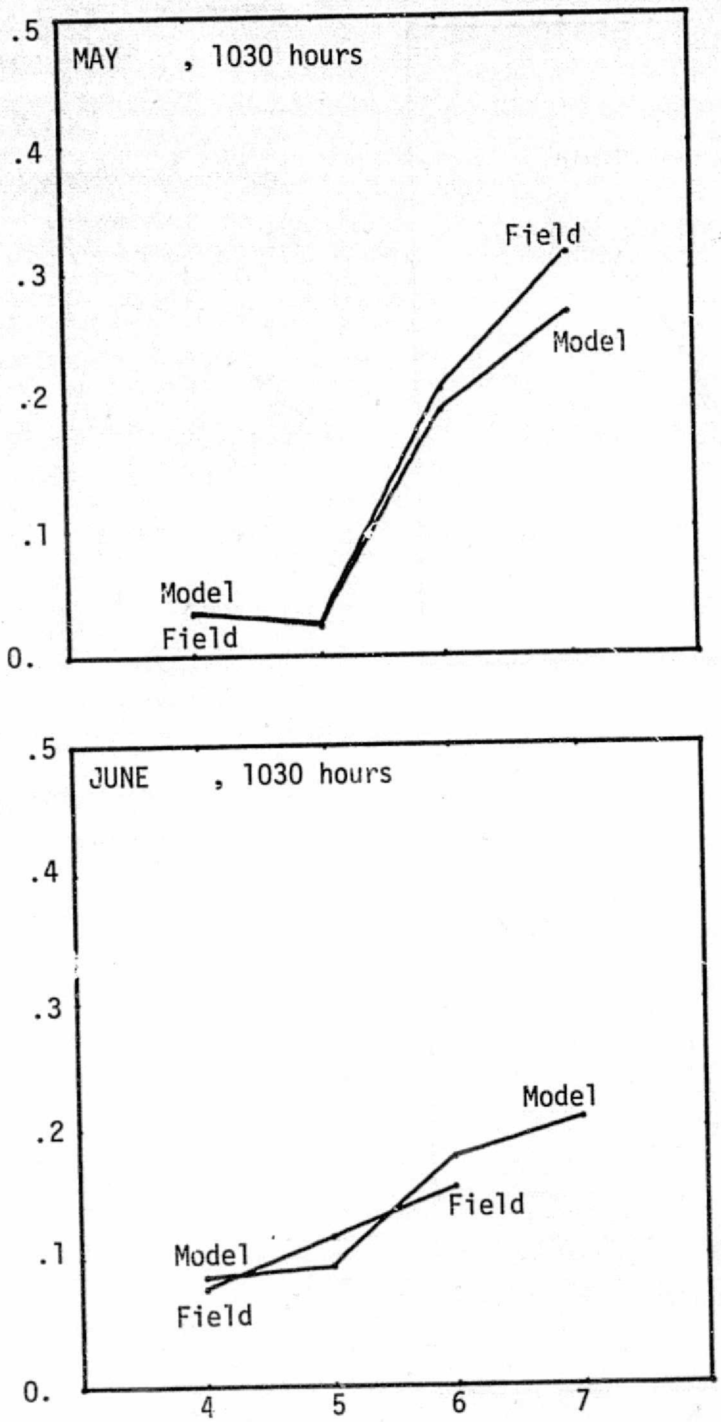


MSS BAND	MODEL	FIELD
4	.050/±.007	.076/±.004
5	.036/.005	.075/.005
6	.262/.004	.264/.031
7	.359/.058	.378/.075



4	.053/.002	.040/.005
5	.037/.001	.025/.005
6	.281/.030	.259/.031
7	.390/.014	.391/.041

FIGURE 1. COMPARISON OF MODEL AND FIELD DATA FOR MARCH AND APRIL



MSS BAND	MODEL	FIELD
4	.035/±.004	.034/±.000
5	.024/.003	.026/.005
6	.192/.021	.209/.028
7	.268/.030	.314/.049

4	.085/.005	.076/.021
5	.093/.006	.116/.026
6	.178/.012	.154/.036
7	.208/.015	--

FIGURE 2. COMPARISON OF MODEL AND FIELD DATA FOR MAY AND JUNE

2.0 Summary of Sun Angle Effects

Tables 1 and 2 in Appendix C present the field measured and canopy modeled scene reflectance as a function of sun angle for each of the LANDSAT bands. In general, as the zenith solar angle increases, the canopy reflectance displays an increasing linear response until 55° zenith, then becomes monotonic. The canopy model's ability to track the empirical data throughout the linear range appears good; however, within the curvilinear region its accuracy degrades (Figures 3 and 4).

The model sun angle/reflectance data was used in developing the alpha, beta coefficient matrices required for the linear sun angle correction algorithm, previously described in Section II of this volume. The primary requirement of the data for this use is that it accurately maps the trend of the data, rather than precisely corresponding to the absolute value of individual points.

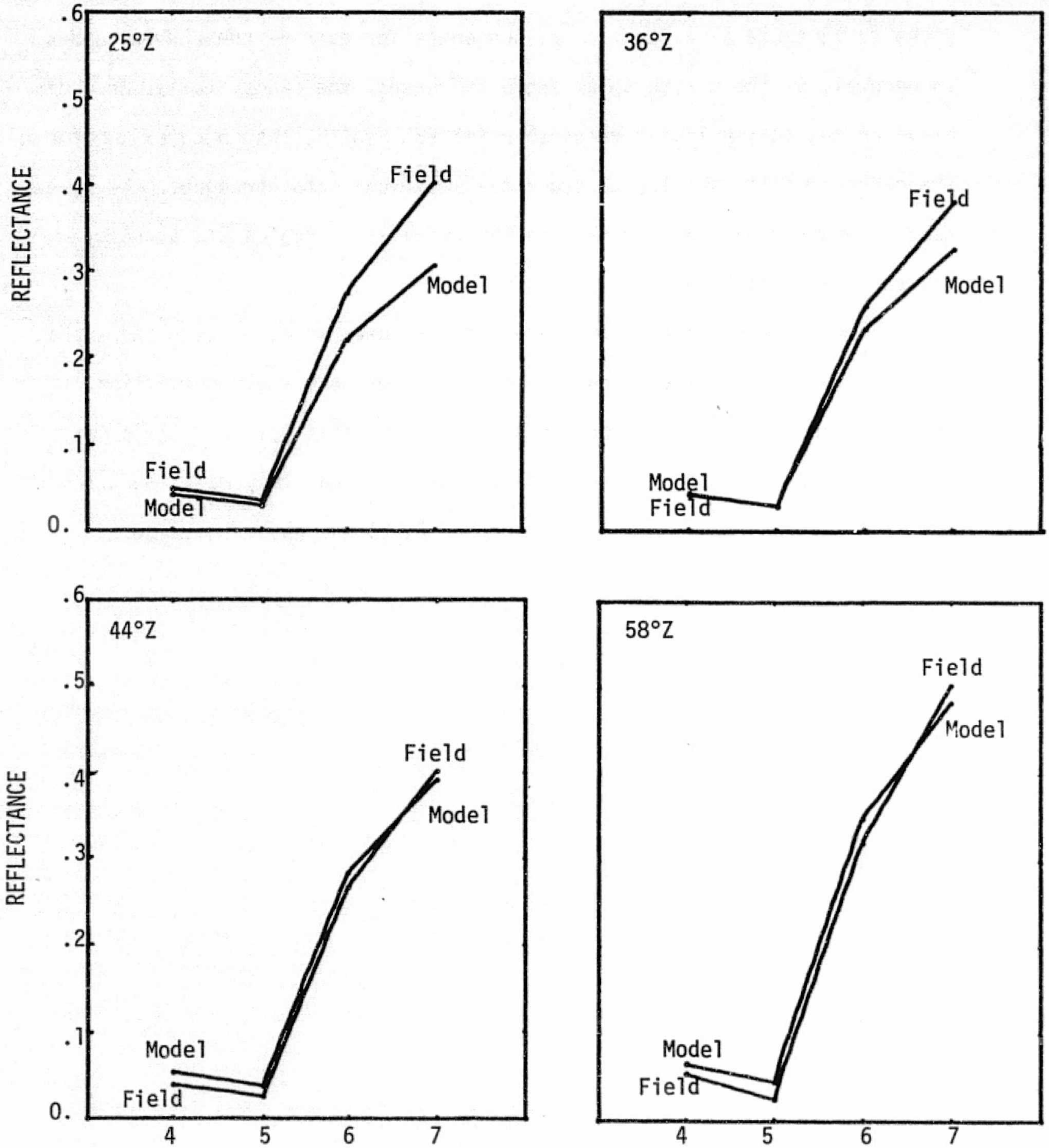


FIGURE 3. Comparison of Model and Field Data for Four Sun Angles in April.

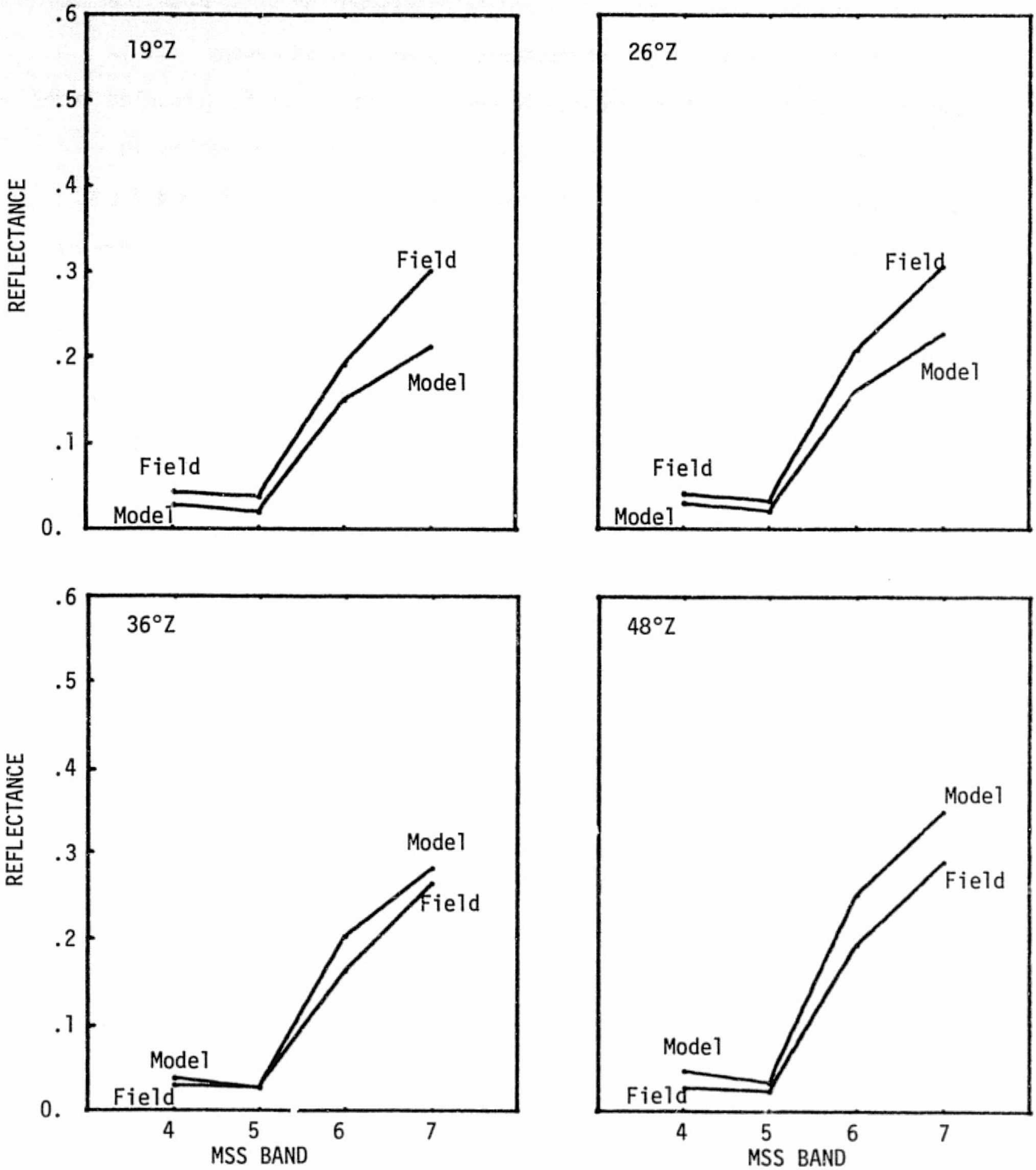


FIGURE 4. Comparison of Model and Field Data for Four Sun Angles in May

IV. INTRINSIC SCENE FEATURES

This section is an initial feasibility assessment of using model derived information to infer intrinsic characteristics of a plant canopy. It is hypothesized that, if these more stable characteristics can be decoupled from the complex scene reflectance, they could be used as feature vectors in classification. For example, a relatively high response in MSS band 7 and a low response in MSS band 4 may be indicative of high biomass, as determined from canopy modeling. The process would involve developing a series of matrices correlating scene reflectance and the intrinsic factor for expected targets, then comparing the remote sensed response with these matrices to infer the level of the intrinsic factor for each target. In the biomass example, a given sensor response may infer a large biomass for both wheat and sugar beets in mid April. However, _a priori_ knowledge allows the dismissal of the classification of sugar beets as it is known that these fields are juvenile in April.

It is not purported that this mode of analysis would replace current methods of classification, but merely offer additional information. Its potential advantages lie in the relative stability of intrinsic characteristics and minimal demands for repetitive ground truth. In addition, once an area is classified as to scene type, an estimate of its status is readily accessible.

This preliminary study is concerned with the determination of leaf area index (LAI), an established measure of the total one-sided surface area of all plants within a unit cube. As this index increases, more dense canopies are indicated. A wheat canopy is used in the study, with the empirical measures being the same as those described in previous sections of this report, and generally presented in Section IV.1, Volume II. Due to the feasibility nature of this investigation, only the tillering (March) and jointing (April) stages

are described. This section consists of four subsections:

1) a comparison of empirical and model estimated reflectance/ LAI relationships;
2) a presentation of the model predicted radiance/LAI relationships at a satellite sensor;
3) an evaluation of the effect of sun angle corrections to April field based radiance/LAI relationship; and
4) recommendations.

1.0 Comparison of Model and Field Data

Figures 1 through 4 graphically portray the relationship between scene reflectance and LAI for both the field measurements and model predictions in March and April. Tables 1 and 2 of Appendix D tabularly summarize the data. The model data for March identifies a positive relationship for MSS bands 4, 6, and 7 which appears to plateau at LAI's above 3.5. Band 5 displays a less prominent negative relationship which also approaches an asymptote at about 3.5 LAI. The model data based on April parameters shows a slight negative relationship for all four bands throughout the 3.5 to 8.5 LAI range. These general trends favorably agree with published studies of a closely related factor, canopy biomass (Pearson, 1973).

The empirical data for these same periods tend to agree with the model data, with the exception of the lowest LAI in March. This discrepancy could arise from either of two sources: 1) the model's inability to precisely respond to low LAI's of a rowed crop, or 2) an anomolous measurement. As the model has generally performed well throughout the rest of the study, the latter source is the most plausible. An overstated field reflectance measurement could easily result through the highly variable soil reflectance contribution and differing percent ground covers. Also contributing could have been the

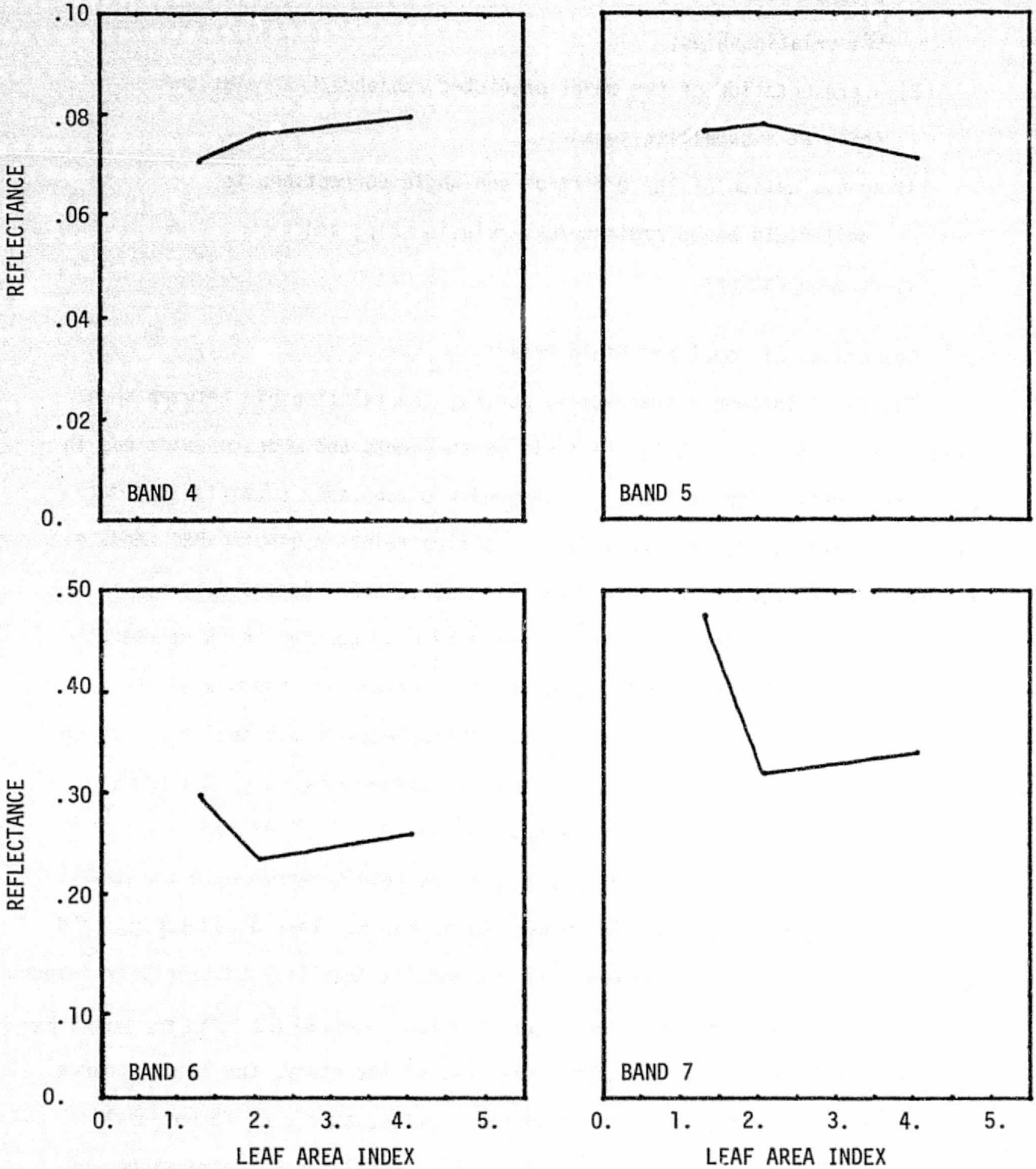


FIGURE 1. Field LAI Effects for March at Surface

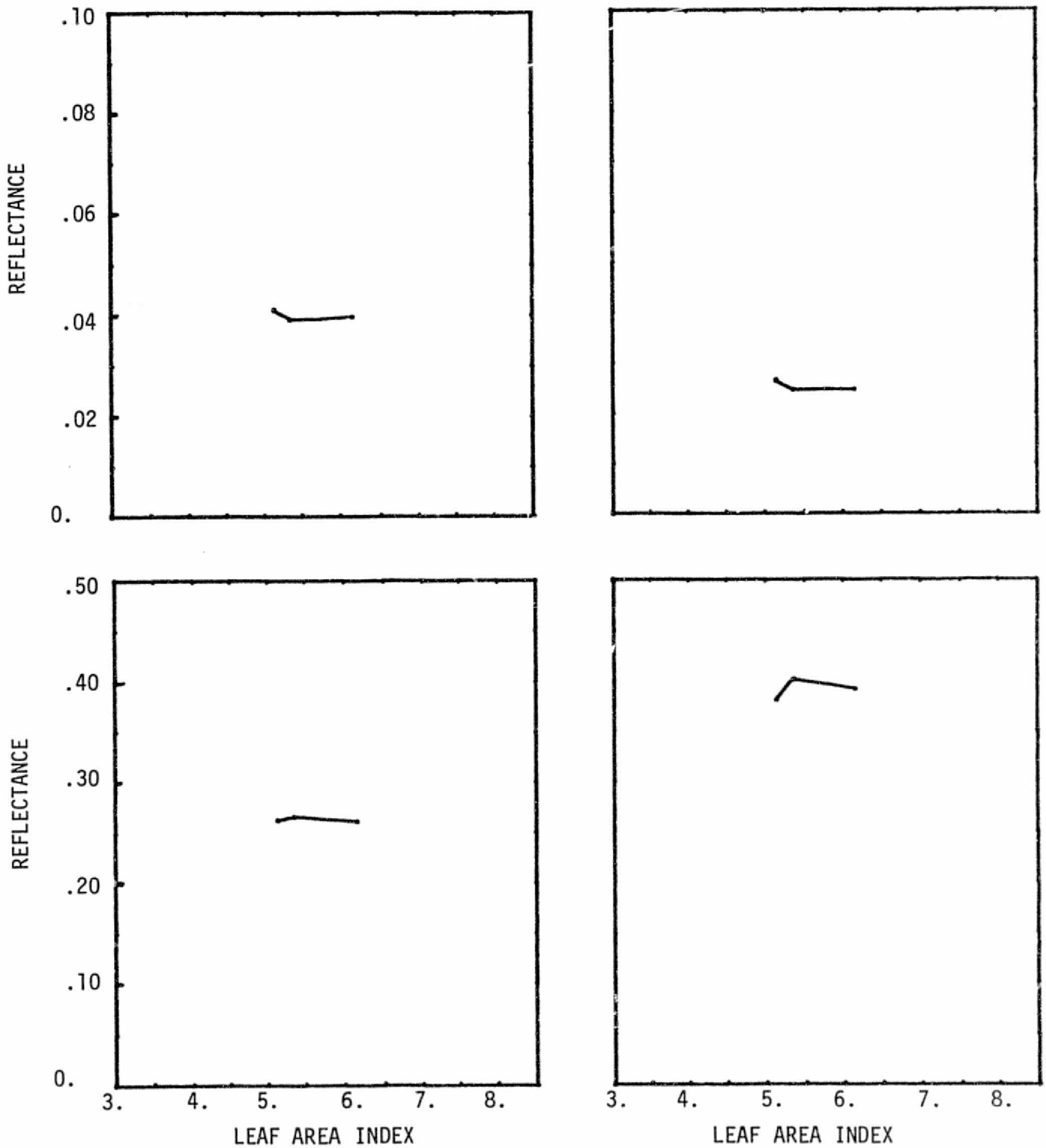


FIGURE 2. Field LAI Effects for April at Surface

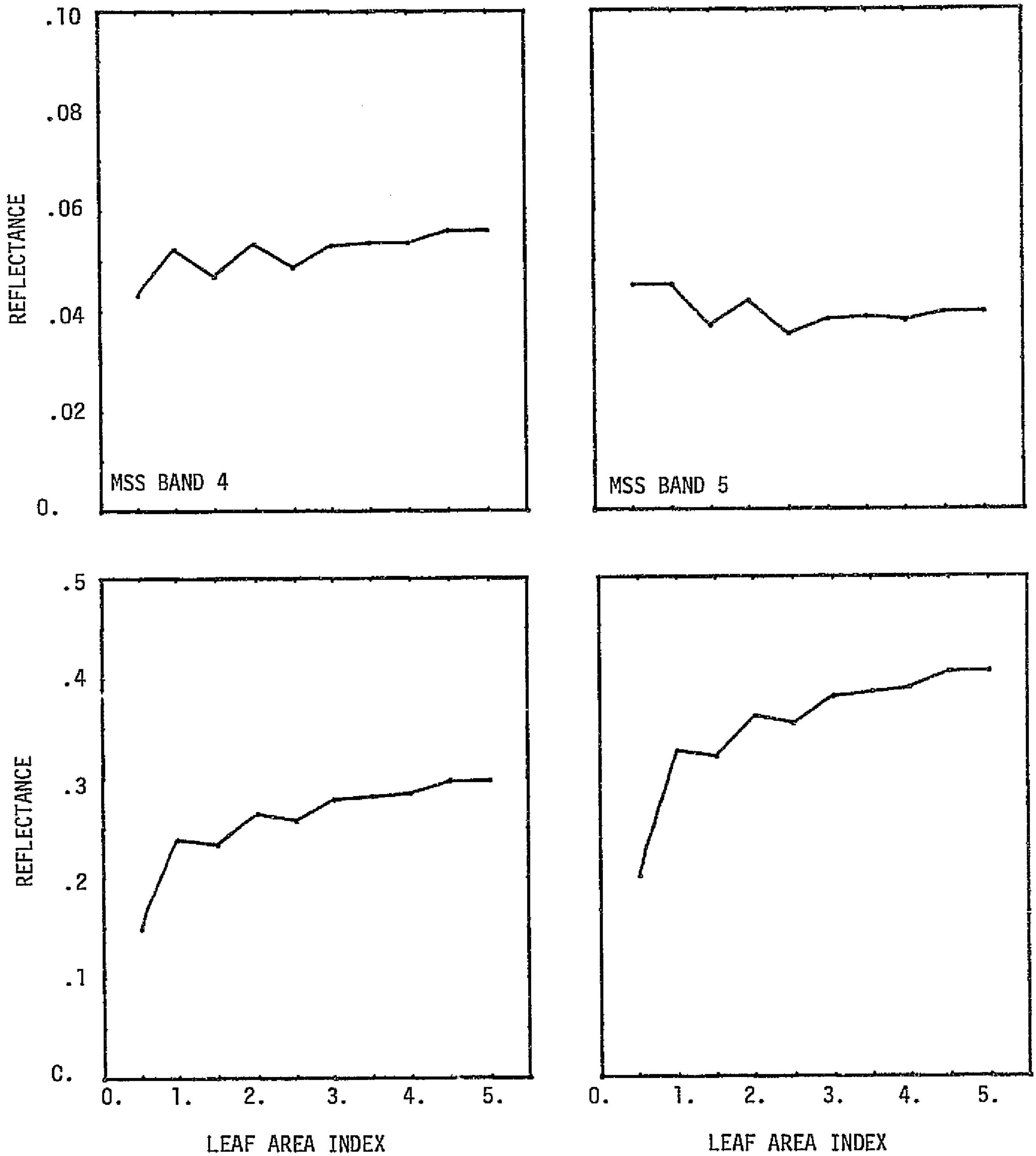


FIGURE 3. MODEL LAI EFFECTS FOR MARCH AT SURFACE

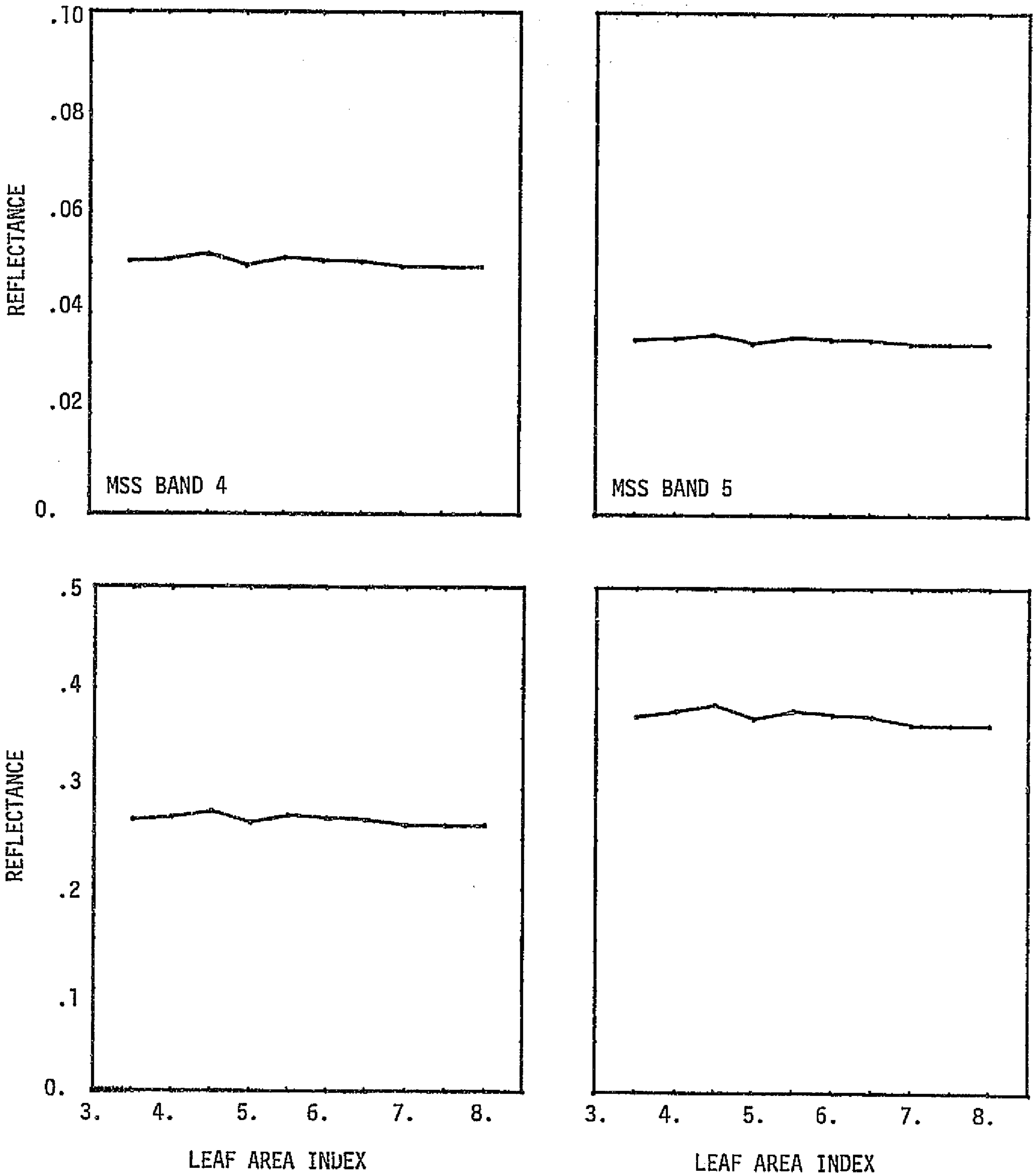


FIGURE 4. MODEL LAI EFFECTS FOR APRIL AT SURFACE

difficulties of selecting and analyzing a subplot of the larger radiometric plot for LAI determination. Past studies in this area, again, support the contention that this point is atypical.

Figure 5 shows that the reflectance ratio of the farthest infrared band (MSS7) to the chlorophyll band (MSS5) increases with plant canopy cover. This ratio has been reported as a good data transformation for assessing changes in scene vegetative biomass (Pearson, 1973), which is closely related to LAI. The characteristic increase in this ratio throughout the lower LAI's, followed by a relatively flat response of higher indices, agrees with the general results of these studies.

2.0 Model Predicted Radiance/LAI Relationship

In extending the scene reflectance/LAI analysis to simulated radiance readings at a satellite platform, the ERIM atmospheric model was utilized. A brief discussion of this procedure is dealt with in Section II of this volume. Figures 6, 7, and 8 and Table 3 of Appendix D present the results.

It is in this form that the inference of the intrinsic scene characteristic of LAI might be derived by comparing compatible sensor signals with the model derived values. This information could become part of the classification processor as an additional feature vector. The effectiveness of this approach could not be evaluated. This initial study, however, outlines a procedure and establishes an initial data set which could lend itself to evaluation.

3.0 Sun Angle Correction of the April Radiance/LAI Relationship

One of the principle attractions for using model derived intrinsic factors is the relative de-emphasis on repetitive ground truth. In order to extend the usefulness of these relationships, corrections for sun angle, a highly variable environmental factor, should be applied. Figure 9 graphically shows

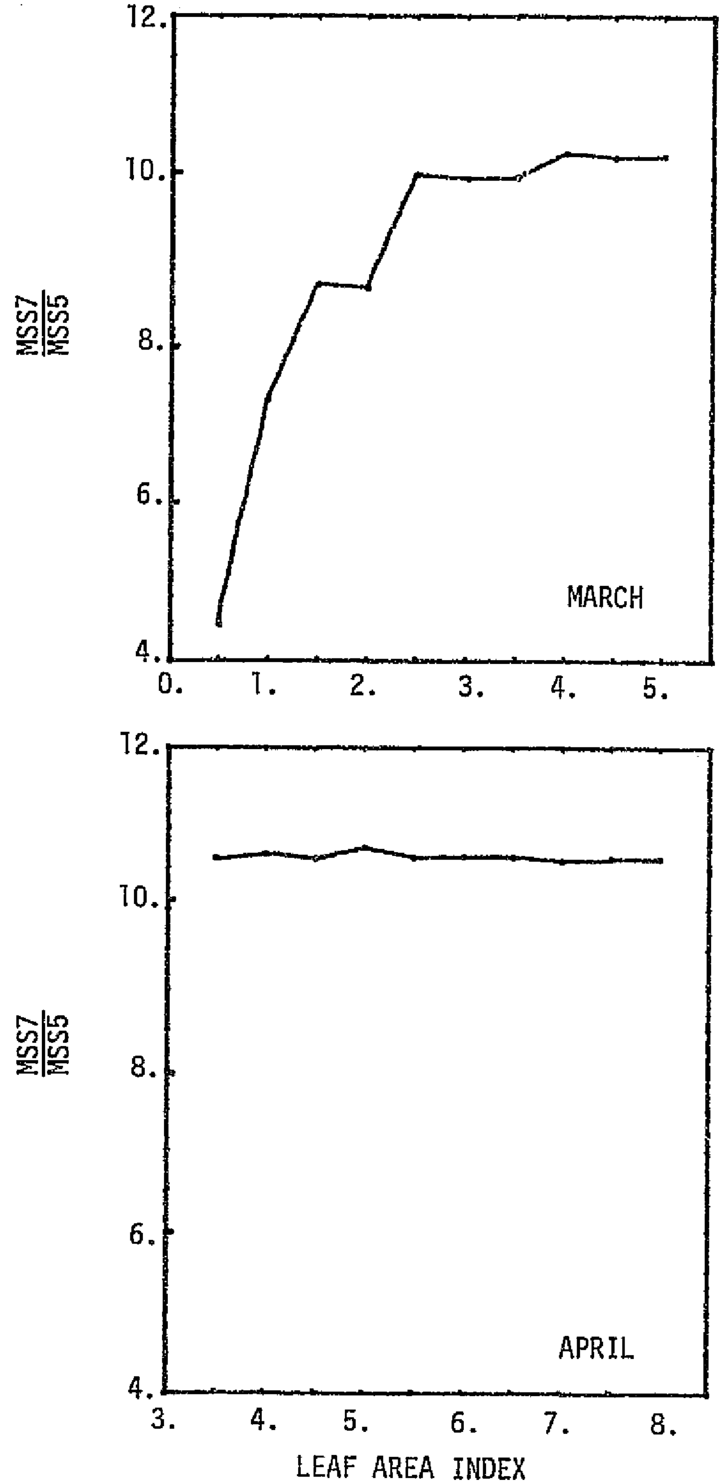


FIGURE 5. Ratio of MSS Bands 7/5 Relationship to LAI for Model Reflectance Data at Surface (Unsmoothed)

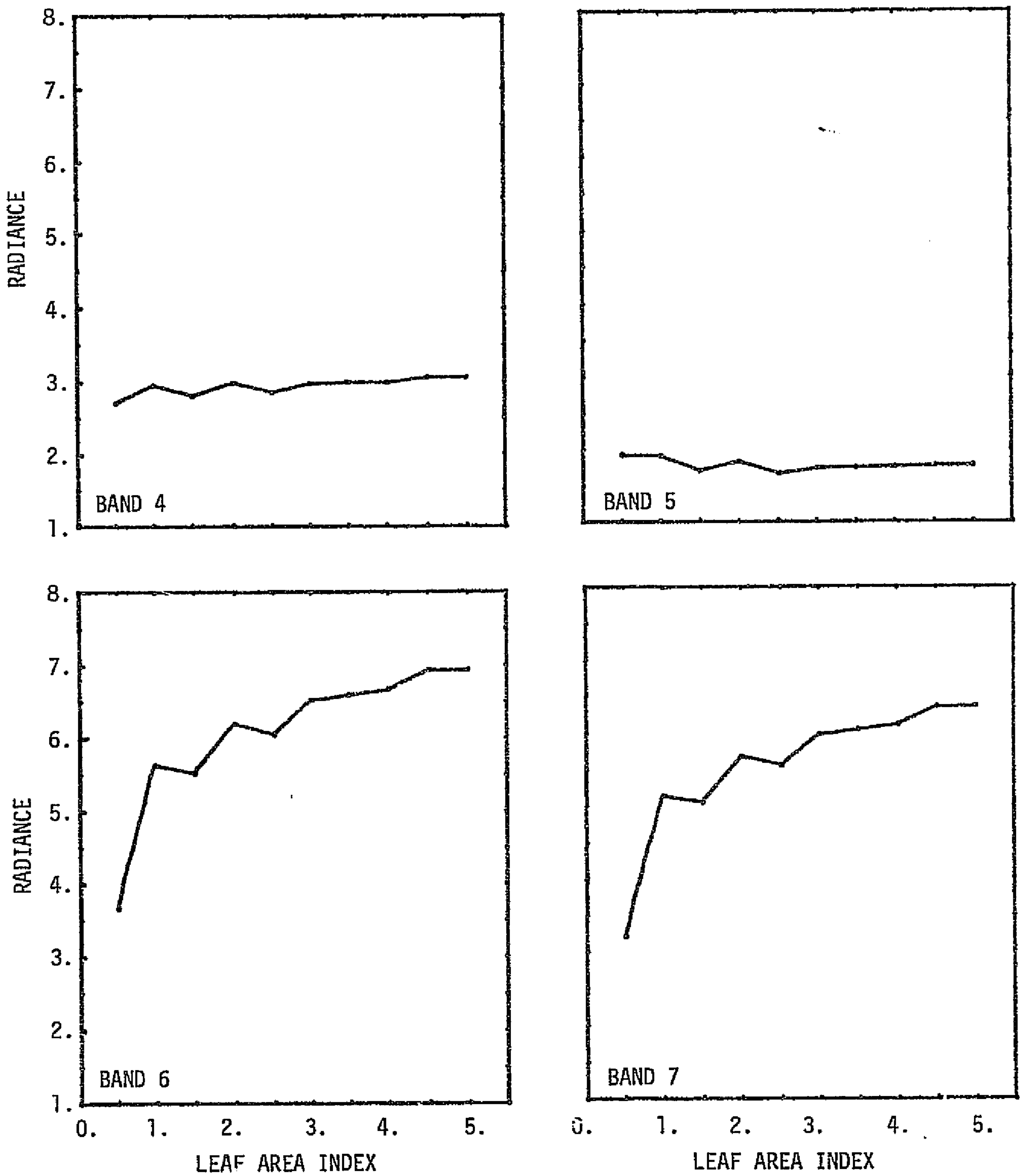


FIGURE 6. Model LAI Effects for March at Satellite (Milliwatts/Square Centimeter/Steradian/Micrometer)

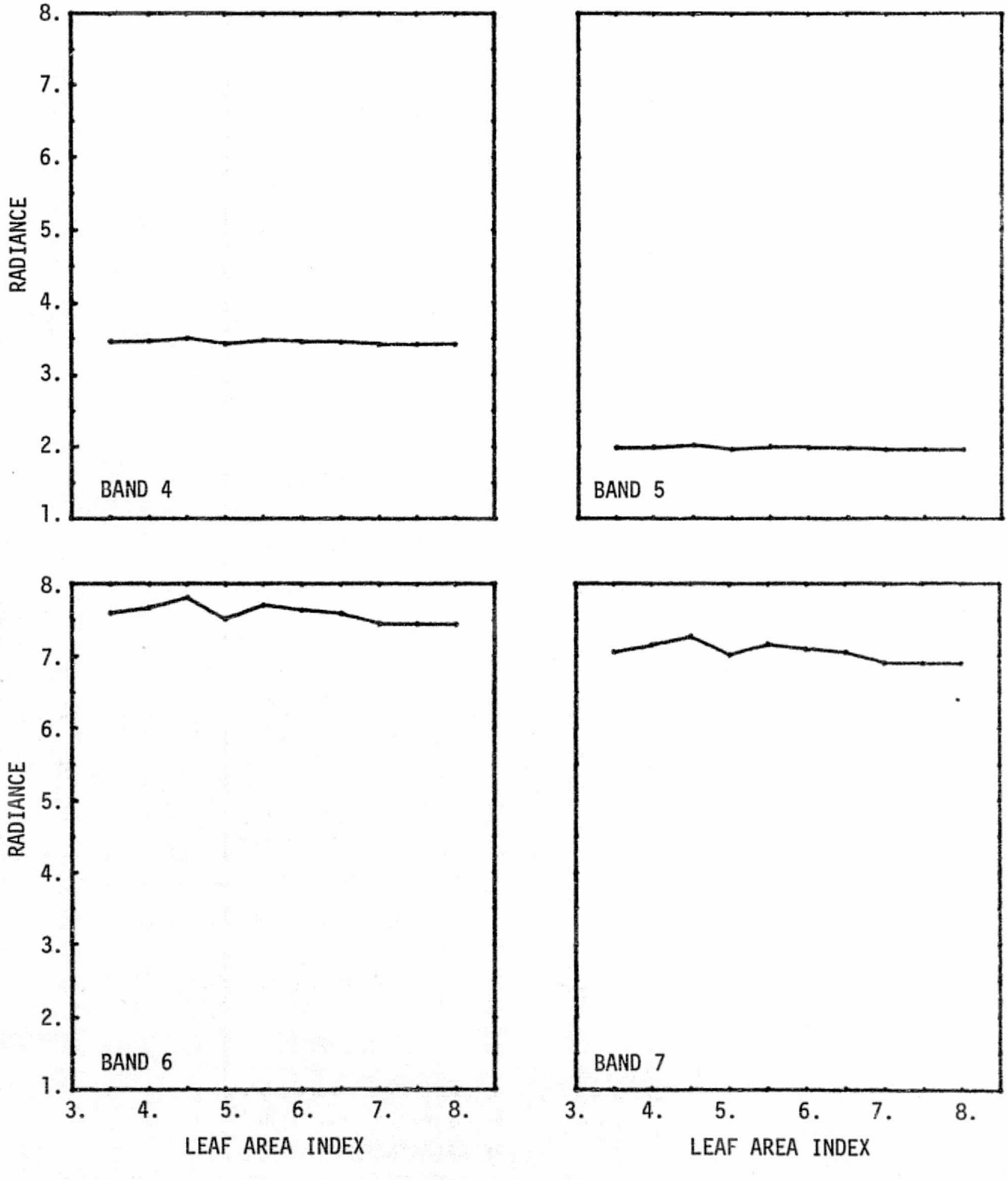


FIGURE 7. Model LAI Effects for April at Satellite
(Milliwatts/Square Centimeter/Steradian/Micrometer)

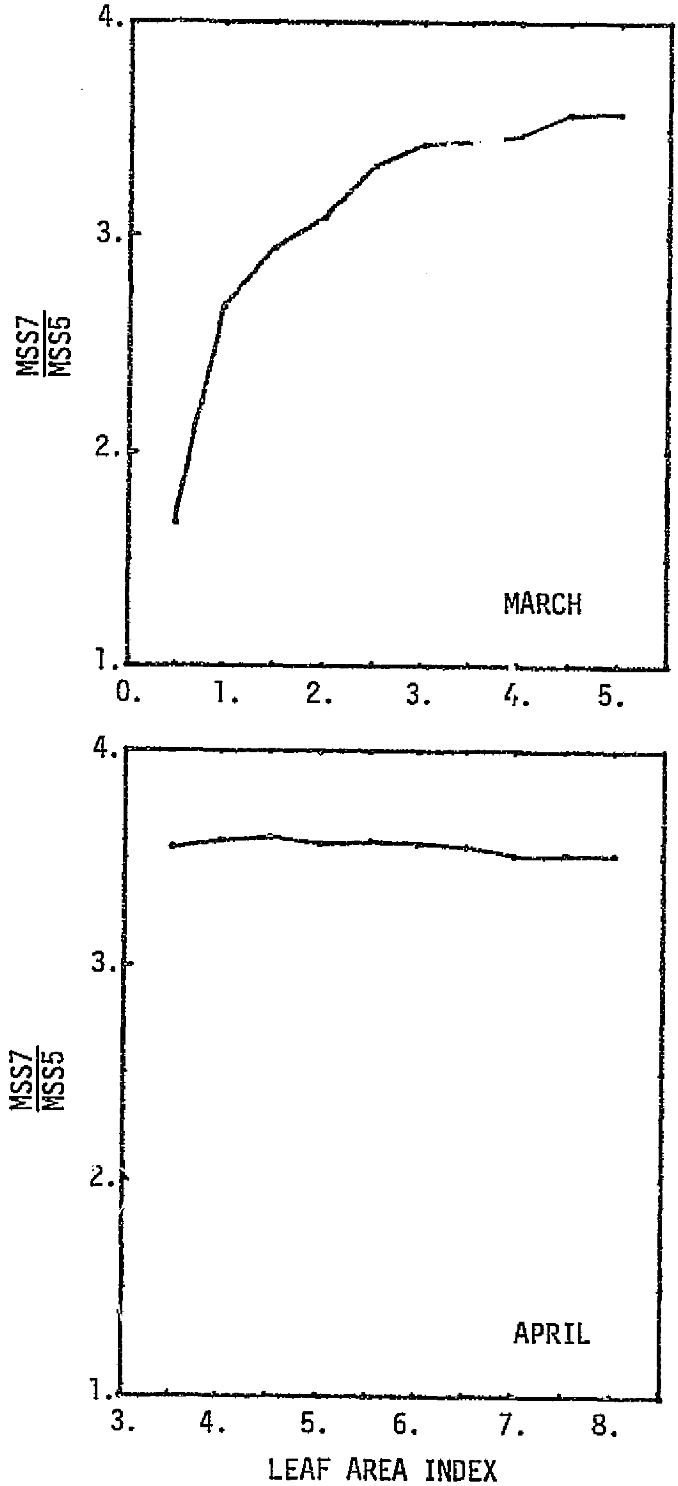


FIGURE 8. Ratio of MSS Bands 7/5 Relationship to LAI for Model Radiance Data at Satellite (Smoothed)

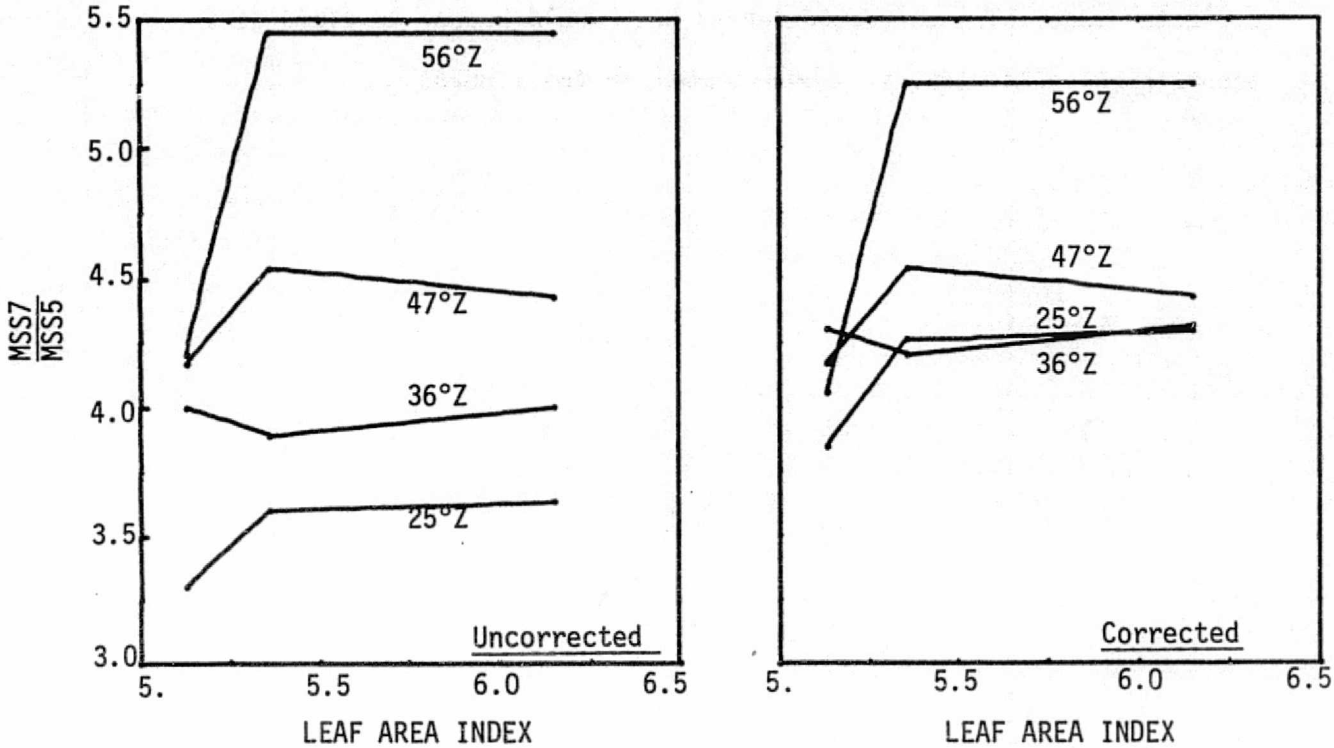


FIGURE 9. Comparison of Uncorrected and Sun Angle Corrected MSS7/5 Radiance Ratio for April

TABLE 1
MEAN AND STANDARD DEVIATION
FOR MSS7/5 RATIO IN APRIL
(Averages Over for Sun Angles)

	Uncorrected		Corrected	
LAI	μ	σ	μ	σ
5.13	3.919	.420	4.092	.192
5.36	4.369	.819	4.562	.482
6.15	4.377	.783	4.570	.456

the effect of correcting for sun angle on the MSS7/5 ratio in April and tabularly summarizes the dispersion of the data in both the uncorrected and corrected mode. The corrected sensor data would appear to yield more accurate LAI estimates, as demonstrated in the figure.

V. CONCLUSIONS AND RECOMMENDATIONS

The correction coefficients identified in Appendix A appear to aid in extending signatures for sun angle variation. Within a restricted zenith sun angle range of 35-50 degrees, it is empirically observed that canopy reflectance is mainly Lambertian. Further, reflectance changes with crop stage are simple shifts in scale in this sun angle range. Thus, choice of correction coefficients calculated using directional or Lambertian canopy reflectance characteristics or as a function of stage is not critical. However, at larger solar zenith angles, the coefficients display much greater variation (10-20%). Consequently, it is recommended that a consistent set of alpha/beta matrices be employed which account for both crop stage and directional reflectance properties for all sun angles. Tables IX, X, XI, XII in Appendix A are a candidate set which satisfy this criteria and could be employed in an operational test.

In this study, it was noted that sun angle variations depend on canopy characteristics. The effects of the vegetative canopy are most pronounced at the larger solar zenith angles (20 percent). The linear sun angle correction coefficients demonstrate a dependency on both crop stage (15-20 percent) and crop type (10-20 percent). A marked disparity betweeen Stage I and Stages II, III and IV coefficients is readily apparent (difference of 15-20 percent). The effect of simulated changes in crop types is greatest for infrared bands (10-20 percent) and for wheat/barley confusion crops.

The use of canopy reflectance modeling allowed for the generation of a simulated data set over an extremely broad envelope of sun angles. In general, the canopy model was able to adequately track the empirical data, with its best estimates occurring in Bands 5 and 6. The relatively less precise pre-

dictions for Stages I and IV are most likely attributable to pronounced rowing effects and incomplete empirical data, respectively. The model is most sensitive to estimates of individual leaf reflectance and transmission. It is anticipated that the forthcoming field season will allow for an improved estimate of these parameters, and subsequent improvement in model predictions.

The use of canopy modeling to infer intrinsic canopy characteristics appears promising. A distinguishable relationship between LAI and canopy reflectance was simulated which favorably compares with empirical studies.

The 1976 field measurement program associated with this study will be basically the same as that of 1975. This continuity will allow for a terse evaluation of expected temporal variation in the canopy variables studied. It is recommended, however, that the canopy modeling field measurement emphasis be shifted from intensively describing single plots, to estimating entire fields. Specific procedural recommendations include: 1) design and construction of an attachment to the LANDSAT Field Radiometer which measures individual leaf reflectance; 2) identify a "sacred radiometric" plot which is repeatedly measured throughout the developmental stages; and 3) collect radiometric data on "clipped" plots to review soil reflectance effects in more detail.

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APPENDIX A: ALPHA AND BETA TABLES

TABLE I. SUN ANGLE CORRECTION COEFFICIENT TABLES FOR MARCH EMPIRICAL DATA SET (AVERAGE LAMBERTIAN REFLECTANCE)

(A) Alpha Table
Wavelength = 0.55 micrometers

θ_1 \ θ_2	35	40	45	50	55
35	1.00	.93	.85	.77	.68
40	-	1.00	.92	.83	.73
45	-	-	1.00	.90	.80
50	-	-	-	1.00	.88
55	-	-	-	-	1.00

(B) Beta Table
Wavelength = 0.55 micrometers

θ_1 \ θ_2	35	40	45	50	55
35	0.00	-.05	-.03	.00	.09
40	-	0.00	.02	.04	.13
45	-	-	0.00	.03	.11
50	-	-	-	0.00	.09
55	-	-	-	-	0.00

(C) Alpha Table
Wavelength = 0.65 micrometers

θ_1 \ θ_2	35	40	45	50	55
35	1.00	.93	.86	.78	.69
40	-	1.00	.92	.83	.74
45	-	-	1.00	.90	.80
50	-	-	-	1.00	.89
55	-	-	-	-	1.00

(D) Beta Table
Wavelength = 0.65 micrometers

θ_1 \ θ_2	35	40	45	50	55
35	0.00	-.03	-.02	-.00	-.04
40	-	0.00	.01	.02	.06
45	-	-	0.00	.01	.06
50	-	-	-	0.00	.04
55	-	-	-	-	0.00

(E) Alpha Table
Wavelength = 0.75 micrometers

θ_1 \ θ_2	35	40	45	50	55
35	1.00	.93	.86	.78	.69
40	-	1.00	.92	.83	.74
45	-	-	1.00	.91	.81
50	-	-	-	1.00	.89
55	-	-	-	-	1.00

(F) Beta Table
Wavelength = 0.75 micrometers

θ_1 \ θ_2	35	40	45	50	55
35	0.00	-.01	-.01	-.00	.02
40	-	0.00	.00	.01	.03
45	-	-	0.00	.01	.03
50	-	-	-	0.00	.02
55	-	-	-	-	0.00

(G) Alpha Table
Wavelength = 0.95 micrometers

θ_1 \ θ_2	35	40	45	50	55
35	1.00	.93	.86	.78	.70
40	-	1.00	.92	.84	.74
45	-	-	1.00	.91	.81
50	-	-	-	1.00	.89
55	-	-	-	-	1.00

(H) Beta Table
Wavelength = 0.95 micrometers

θ_1 \ θ_2	35	40	45	50	55
35	0.00	-.01	-.00	.00	.01
40	-	0.00	.00	.01	.02
45	-	-	0.00	.00	.01
50	-	-	-	0.00	.01
55	-	-	-	-	0.00

TABLE II. SUN ANGLE CORRECTION COEFFICIENT TABLES FOR APRIL EMPIRICAL DATA SET (AVERAGE LAMBERTIAN REFLECTANCE)

(A) Alpha Table
Wavelength = 0.55 micrometers

θ_1 θ_2	25	30	35	40	45	50	55	60
25	1.00	.95	.90	.84	.77	.69	.61	.53
30	-	1.00	.94	.88	.80	.73	.64	.55
35	-	-	1.00	.93	.85	.77	.68	.59
40	-	-	-	1.00	.92	.83	.73	.63
45	-	-	-	-	1.00	.90	.80	.68
50	-	-	-	-	-	1.00	.88	.76
55	-	-	-	-	-	-	1.00	.86
60	-	-	-	-	-	-	-	1.00

(B) Beta Table
Wavelength = 0.55 micrometers

θ_1 θ_2	25	30	35	40	45	50	55	60
25	0.00	-.18	-.21	-.25	-.21	-.16	-.05	.05
30	-	0.00	-.04	-.09	-.07	-.03	.06	.15
35	-	-	0.00	-.05	-.03	.00	.09	.18
40	-	-	-	0.00	.02	.04	.13	.21
45	-	-	-	-	0.00	.03	.11	.20
50	-	-	-	-	-	0.00	.09	.17
55	-	-	-	-	-	-	0.00	.10
60	-	-	-	-	-	-	-	0.00

(C) Alpha Table
Wavelength = 0.65 micrometers

θ_1 θ_2	25	30	35	40	45	50	55	60
25	1.00	.95	.90	.84	.77	.70	.62	.54
30	-	1.00	.94	.88	.81	.73	.65	.56
35	-	-	1.00	.93	.86	.78	.69	.60
40	-	-	-	1.00	.92	.83	.74	.64
45	-	-	-	-	1.00	.90	.80	.69
50	-	-	-	-	-	1.00	.89	.77
55	-	-	-	-	-	-	1.00	.87
60	-	-	-	-	-	-	-	1.00

(D) Beta Table
Wavelength = 0.65 micrometers

θ_1 θ_2	25	30	35	40	45	50	55	60
25	0.00	-.09	-.11	-.13	-.11	-.09	-.03	.02
30	-	0.00	-.02	-.05	-.04	-.02	.03	.07
35	-	-	0.00	-.03	-.02	.00	.04	.08
40	-	-	-	0.00	.01	.02	.06	.01
45	-	-	-	-	0.00	.01	.06	.10
50	-	-	-	-	-	0.00	.05	.09
55	-	-	-	-	-	-	0.00	.05
60	-	-	-	-	-	-	-	0.00

(E) Alpha Table
Wavelength = 0.75 micrometers

θ_1 θ_2	25	30	35	40	45	50	55	60
25	1.00	.95	.90	.84	.77	.70	.62	.54
30	-	1.00	.94	.88	.81	.74	.65	.57
35	-	-	1.00	.93	.86	.78	.69	.60
40	-	-	-	1.00	.92	.83	.74	.64
45	-	-	-	-	1.00	.91	.81	.70
50	-	-	-	-	-	1.00	.89	.77
55	-	-	-	-	-	-	1.00	.87
60	-	-	-	-	-	-	-	1.00

(F) Beta Table
Wavelength = 0.75 micrometers

θ_1 θ_2	25	30	35	40	45	50	55	60
25	0.00	-.05	-.06	-.07	-.06	-.05	-.02	.01
30	-	0.00	-.01	-.03	-.02	-.01	.01	.04
35	-	-	0.00	-.01	-.01	.00	.02	.05
40	-	-	-	0.00	.01	.01	.03	.06
45	-	-	-	-	0.00	.01	.03	.06
50	-	-	-	-	-	0.00	.02	.05
55	-	-	-	-	-	-	0.00	.03
60	-	-	-	-	-	-	-	0.00

April - Lambertian

(G) Alpha Table
Wavelength = 0.95 micrometers

θ_1 \ θ_2	25	30	35	40	45	50	55	60
25	1.00	.96	.90	.84	.78	.71	.63	.55
30	-	1.00	.95	.88	.81	.74	.66	.57
35	-	-	1.00	.93	.86	.78	.70	.60
40	-	-	-	1.00	.92	.84	.74	.65
45	-	-	-	-	1.00	.91	.81	.70
50	-	-	-	-	-	1.00	.89	.77
55	-	-	-	-	-	-	1.00	.87
60	-	-	-	-	-	-	-	1.00

(H) Beta Table
Wavelength = 0.95 micrometers

θ_1 \ θ_2	25	30	35	40	45	50	55	60
25	0.00	-.02	-.02	-.02	-.02	-.01	.00	.01
30	-	0.00	.00	-.01	-.01	.00	.01	.02
35	-	-	0.00	.00	.00	.00	.01	.02
40	-	-	-	0.00	.00	.01	.02	.03
45	-	-	-	-	0.00	.00	.01	.02
50	-	-	-	-	-	0.00	.01	.02
55	-	-	-	-	-	-	0.00	.01
60	-	-	-	-	-	-	-	0.00

TABLE III. SUN ANGLE CORRECTION COEFFICIENT TABLES FOR MAY EMPIRICAL DATA SET (AVERAGE LAMBERTIAN REFLECTANCE)

(A) Alpha Table
Wavelength = 0.55 micrometers

θ_1 \ θ_2	20	25	30	35	40	45	50	55
20	1.00	.96	.92	.86	.80	.74	.67	.59
25	-	1.00	.95	.90	.84	.77	.69	.61
30	-	-	1.00	.94	.88	.80	.73	.64
35	-	-	-	1.00	.93	.85	.77	.68
40	-	-	-	-	1.00	.92	.83	.73
45	-	-	-	-	-	1.00	.90	.80
50	-	-	-	-	-	-	1.00	.88
55	-	-	-	-	-	-	-	1.00

(B) Beta Table
Wavelength = 0.55 micrometers

θ_1 \ θ_2	20	25	30	35	40	45	50	55
20	0.00	-.14	-.31	-.34	-.36	-.32	-.26	-.14
25	-	0.00	-.18	-.21	-.25	-.21	-.16	-.06
30	-	-	0.00	-.04	-.09	-.07	-.03	.06
35	-	-	-	0.00	-.05	-.03	.00	.09
40	-	-	-	-	0.00	.02	.04	.13
45	-	-	-	-	-	0.00	.03	.11
50	-	-	-	-	-	-	0.00	.09
55	-	-	-	-	-	-	-	0.00

(C) Alpha Table
Wavelength = 0.65 micrometers

θ_1 \ θ_2	20	25	30	35	40	45	50	55
20	1.00	.96	.92	.87	.81	.74	.67	.60
25	-	1.00	.95	.90	.84	.77	.70	.62
30	-	-	1.00	.94	.88	.81	.73	.65
35	-	-	-	1.00	.93	.86	.78	.69
40	-	-	-	-	1.00	.92	.83	.74
45	-	-	-	-	-	1.00	.90	.80
50	-	-	-	-	-	-	1.00	.89
55	-	-	-	-	-	-	-	1.00

(D) Beta Table
Wavelength = 0.65 micrometers

θ_1 θ_2	20	25	30	35	40	45	50	55
20	0.00	-.07	-.16	-.17	-.19	-.17	-.14	-.08
25	-	0.00	-.09	-.11	-.13	-.11	-.09	-.04
30	-	-	0.00	-.02	-.05	-.04	-.02	.02
35	-	-	-	0.00	-.03	-.02	-.00	.04
40	-	-	-	-	0.00	.01	.02	.06
45	-	-	-	-	-	0.00	.01	.05
50	-	-	-	-	-	-	0.00	.04
55	-	-	-	-	-	-	-	0.00

(E) Alpha Table
Wavelength = 0.75 micrometers

θ_1 θ_2	20	25	30	35	40	45	50	55
20	1.00	.96	.92	.87	.81	.75	.68	.60
25	-	1.00	.95	.90	.84	.77	.70	.62
30	-	-	1.00	.94	.88	.81	.74	.65
35	-	-	-	1.00	.93	.86	.78	.69
40	-	-	-	-	1.00	.92	.83	.74
45	-	-	-	-	-	1.00	.91	.80
50	-	-	-	-	-	-	1.00	.89
55	-	-	-	-	-	-	-	1.00

(F) Beta Table
Wavelength = 0.75 micrometers

θ_1 θ_2	20	25	30	35	40	45	50	55
20	0.00	-.04	-.98	-.09	-.10	-.09	-.07	-.04
25	-	0.00	-.05	-.06	-.07	-.06	-.05	-.02
30	-	-	0.00	-.01	-.03	-.02	-.01	.01
35	-	-	-	0.00	-.02	-.01	-.00	.02
40	-	-	-	-	0.00	.00	.01	.03
45	-	-	-	-	-	0.00	.01	.03
50	-	-	-	-	-	-	0.00	.02
55	-	-	-	-	-	-	-	0.00

(G) Alpha Table
Wavelength = 0.95 micrometers

θ_1 \ θ_2	20	25	30	35	40	45	50	55
20	1.00	.96	.92	.87	.81	.75	.68	.61
25	-	1.00	.95	.90	.84	.78	.70	.63
30	-	-	1.00	.95	.88	.81	.74	.66
35	-	-	-	1.00	.93	.86	.78	.70
40	-	-	-	-	1.00	.92	.84	.74
45	-	-	-	-	-	1.00	.91	.81
50	-	-	-	-	-	-	1.00	.39
55	-	-	-	-	-	-	-	1.00

(H) Beta Table
Wavelength = 0.95 micrometers

θ_1 \ θ_2	20	25	30	35	40	45	50	55
20	0.00	-.01	-.03	-.03	-.03	-.03	-.02	-.01
25	-	0.00	-.02	-.02	-.02	-.02	-.01	.00
30	-	-	0.00	-.01	-.01	-.01	.00	.01
35	-	-	-	0.00	-.01	.00	.00	.01
40	-	-	-	-	0.00	.00	.00	.02
45	-	-	-	-	-	0.00	.00	.01
50	-	-	-	-	-	-	0.00	.01
55	-	-	-	-	-	-	-	0.00

TABLE IV. SUN ANGLE CORRECTION COEFFICIENT TABLES FOR JUNE EMPIRICAL DATA SET (AVERAGE LAMBERTIAN REFLECTANCE)

(A) Alpha Table
Wavelength = 0.55 micrometers

θ_1 \ θ_2	15	20	25	30	35	40	45	50
15	1.00	.97	.93	.89	.84	.78	.72	.65
20	-	1.00	.96	.92	.86	.80	.74	.67
25	-	-	1.00	.95	.90	.84	.77	.69
30	-	-	-	1.00	.94	.88	.81	.73
35	-	-	-	-	1.00	.93	.85	.77
40	-	-	-	-	-	1.00	.92	.83
45	-	-	-	-	-	-	1.00	.90
50	-	-	-	-	-	-	-	1.00

(B) Beta Table
Wavelength = 0.55 micrometers

θ_1 \ θ_2	15	20	25	30	35	40	45	50
15	0.00	-.33	-.46	-.62	-.62	-.63	-.56	-.48
20	-	0.00	-.14	-.31	-.34	-.36	-.32	-.26
25	-	-	0.00	-.18	-.21	-.25	-.21	-.16
30	-	-	-	0.00	-.04	-.09	-.07	-.03
35	-	-	-	-	0.00	-.05	-.03	.00
40	-	-	-	-	-	0.00	.02	.04
45	-	-	-	-	-	-	0.00	.03
50	-	-	-	-	-	-	-	0.00

(C) Alpha Table
Wavelength = 0.65 micrometers

θ_1 \ θ_2	15	20	25	30	35	40	45	50
15	1.00	.97	.94	.89	.84	.79	.72	.65
20	-	1.00	.96	.92	.87	.81	.74	.67
25	-	-	1.00	.95	.90	.84	.77	.70
30	-	-	-	1.00	.94	.88	.81	.73
35	-	-	-	-	1.00	.93	.86	.78
40	-	-	-	-	-	1.00	.92	.83
45	-	-	-	-	-	-	1.00	.90
50	-	-	-	-	-	-	-	1.00

(D) Beta Table
Wavelength = 0.65 micrometers

θ_1 θ_2	15	20	25	30	35	40	45	50
15	0.00	-.15	-.21	-.29	-.30	-.31	-.28	-.24
20	-	0.00	-.07	-.16	-.17	-.19	-.17	-.14
25	-	-	0.00	-.09	-.11	-.13	-.11	-.09
30	-	-	-	0.00	-.02	-.05	-.04	-.02
35	-	-	-	-	0.00	-.03	-.09	.00
40	-	-	-	-	-	0.00	.01	.02
45	-	-	-	-	-	-	0.00	.01
50	-	-	-	-	-	-	-	0.00

(E) Alpha Table
Wavelength = 0.75 micrometers

θ_1 θ_2	15	20	25	30	35	40	45	50
15	1.00	.97	.94	.89	.84	.79	.73	.66
20	-	1.00	.96	.92	.87	.81	.75	.68
25	-	-	1.00	.95	.90	.84	.77	.70
30	-	-	-	1.00	.94	.88	.81	.74
35	-	-	-	-	1.00	.93	.86	.78
40	-	-	-	-	-	1.00	.92	.83
45	-	-	-	-	-	-	1.00	.91
50	-	-	-	-	-	-	-	1.00

(F) Beta Table
Wavelength = 0.75 micrometers

θ_1 θ_2	15	20	25	30	35	40	45	50
15	0.00	-.07	-.10	-.15	-.15	-.15	-.14	-.12
20	-	0.00	-.04	-.08	-.09	-.10	-.09	-.07
25	-	-	0.00	-.05	-.06	-.07	-.06	-.05
30	-	-	-	0.00	-.01	-.03	-.02	-.01
35	-	-	-	-	0.00	-.01	-.01	.00
40	-	-	-	-	-	0.00	.00	.00
45	-	-	-	-	-	-	0.00	.00
50	-	-	-	-	-	-	-	0.00

TABLE V. SUN ANGLE CORRECTION COEFFICIENT TABLES FOR MARCH EMPIRICAL DATA SET (AVERAGE DIRECTIONAL REFLECTANCE)

(A) Alpha Table
Wavelength = 0.55 micrometers

θ_1 \ θ_2	35	40	45	50	55
35	1.00	.98	.93	.87	.79
40	-	1.00	.95	.89	.81
45	-	-	1.00	.94	.86
50	-	-	-	1.00	.91
55	-	-	-	-	1.00

(B) Beta Table
Wavelength = 0.55 micrometers

θ_1 \ θ_2	35	40	45	50	55
35	0.00	-.14	-.17	-.20	-.14
40	-	0.00	-.04	-.07	-.02
45	-	-	0.00	-.04	.01
50	-	-	-	0.00	.05
55	-	-	-	-	0.00

(C) Alpha Table
Wavelength = 0.65 micrometers

θ_1 \ θ_2	35	40	45	50	55
35	1.00	1.02	1.04	1.00	.95
40	-	1.00	1.02	.98	.93
45	-	-	1.00	.96	.91
50	-	-	-	1.00	.95
55	-	-	-	-	1.00

(D) Beta Table
Wavelength = 0.65 micrometers

θ_1 \ θ_2	35	40	45	50	55
35	0.00	-.11	-.20	-.23	-.22
40	-	0.00	-.09	-.12	-.17
45	-	-	0.00	-.03	-.03
50	-	-	-	0.00	.00
55	-	-	-	-	0.00

(E) Alpha Table
Wavelength = 0.75 micrometers

θ_1 \ θ_2	35	40	45	50	55
35	1.00	.98	.94	.88	.81
40	-	1.00	.95	.90	.83
45	-	-	1.00	.94	.87
50	-	-	-	1.00	.92
55	-	-	-	-	1.00

(F) Beta Table
Wavelength = 0.75 micrometers

θ_1 \ θ_2	35	40	45	50	55
35	0.00	-.04	-.05	-.06	-.04
40	-	0.00	-.01	-.02	-.01
45	-	-	0.00	-.01	.00
50	-	-	-	0.00	.01
55	-	-	-	-	0.00

(G) Alpha Table
Wavelength = 0.95 micrometers

θ_1 \ θ_2	35	40	45	50	55
35	1.00	.96	.90	.83	.76
40	-	1.00	.94	.87	.80
45	-	-	1.00	.92	.85
50	-	-	-	1.00	.92
55	-	-	-	-	1.00

(H) Beta Table
Wavelength = 0.95 micrometers

θ_1 \ θ_2	35	40	45	50	55
35	0.00	-.01	-.01	-.01	.00
40	-	0.00	.00	.00	.01
45	-	-	0.00	.00	.01
50	-	-	-	0.00	.01
55	-	-	-	-	0.00

TABLE VI. SUN ANGLE CORRECTION COEFFICIENT TABLES FOR APRIL EMPIRICAL DATA SET (AVERAGE DIRECTIONAL REFLECTANCE)

(A) Alpha Table
Wavelength = 0.55 micrometers

θ_1 \ θ_2	25	30	35	40	45	50	55	60
25	1.00	.90	.78	.68	.59	.53	.49	.51
30	-	1.00	.86	.75	.66	.59	.55	.56
35	-	-	1.00	.87	.76	.69	.63	.65
40	-	-	-	1.00	.87	.79	.73	.74
45	-	-	-	-	1.00	.90	.84	.85
50	-	-	-	-	-	1.00	.93	.94
55	-	-	-	-	-	-	1.00	1.02
60	-	-	-	-	-	-	-	1.00

(B) Beta Table
Wavelength = 0.55 micrometers

θ_1 \ θ_2	25	30	35	40	45	50	55	60
25	0.00	-.05	.08	.14	.22	.23	.23	.10
30	-	0.00	.12	.18	.25	.25	.25	.13
35	-	-	0.00	.07	.15	.17	.18	.05
40	-	-	-	0.00	.09	.11	.12	.00
45	-	-	-	-	0.00	.03	.05	-.08
50	-	-	-	-	-	0.00	.02	-.11
55	-	-	-	-	-	-	0.00	-.13
60	-	-	-	-	-	-	-	0.00

(C) Alpha Table
Wavelength = 0.65 micrometers

θ_1 \ θ_2	25	30	35	40	45	50	55	60
25	1.00	.91	.81	.68	.58	.49	.38	.30
30	-	1.00	.89	.74	.64	.54	.42	.33
35	-	-	1.00	.83	.72	.61	.46	.37
40	-	-	-	1.00	.86	.73	.56	.44
45	-	-	-	-	1.00	.85	.65	.51
50	-	-	-	-	-	1.00	.76	.61
55	-	-	-	-	-	-	1.00	.80
60	-	-	-	-	-	-	-	1.00

(D) Beta Table
Wavelength = 0.65 micrometers

θ_1 \ θ_2	25	30	35	40	45	50	55	60
25	0.00	-.03	.00	.07	.12	.16	.26	.31
30	-	0.00	.03	.10	.14	.18	.28	.32
35	-	-	0.00	.07	.12	.17	.27	.31
40	-	-	-	0.00	.06	.11	.22	.28
45	-	-	-	-	0.00	.06	.19	.25
50	-	-	-	-	-	0.00	.14	.21
55	-	-	-	-	-	-	0.00	.10
60	-	-	-	-	-	-	-	0.00

(E) Alpha Table
Wavelength = 0.75 micrometers

θ_1 \ θ_2	25	30	35	40	45	50	55	60
25	1.00	.95	.88	.82	.75	.68	.62	.66
30	-	1.00	.93	.86	.79	.72	.66	.69
35	-	-	1.00	.93	.85	.77	.71	.74
40	-	-	-	1.00	.92	.83	.76	.80
45	-	-	-	-	1.00	.91	.83	.87
50	-	-	-	-	-	1.00	.91	.96
55	-	-	-	-	-	-	1.00	1.05
60	-	-	-	-	-	-	-	1.00

(F) Beta Table
Wavelength = 0.75 micrometers

θ_1 \ θ_2	25	30	35	40	45	50	55	60
25	0.00	-.04	-.05	-.05	-.04	-.03	-.02	-.01
30	-	0.00	-.01	-.02	-.01	.00	.01	-.03
35	-	-	0.00	-.01	.00	.00	.02	-.03
40	-	-	-	0.00	.01	.01	.03	-.02
45	-	-	-	-	0.00	.01	.02	-.02
50	-	-	-	-	-	0.00	.01	-.03
55	-	-	-	-	-	-	0.00	-.05
60	-	-	-	-	-	-	-	0.00

April - Directional

(G) Alpha Table
Wavelength = 0.95 micrometers

θ_1 \ θ_2	25	30	35	40	45	50	55	60
25	1.00	.94	.88	.82	.75	.69	.64	.68
30	-	1.00	.93	.86	.79	.73	.68	.72
35	-	-	1.00	.93	.85	.78	.73	.77
40	-	-	-	1.00	.92	.84	.79	.83
45	-	-	-	-	1.00	.92	.86	.91
50	-	-	-	-	-	1.00	.94	.99
55	-	-	-	-	-	-	1.00	1.06
60	-	-	-	-	-	-	-	1.00

(H) Beta Table
Wavelength = 0.95 micrometers

θ_1 \ θ_2	25	30	35	40	45	50	55	60
25	0.00	-.01	-.01	-.02	-.01	-.01	-.01	-.02
30	-	0.00	.00	-.01	.00	.00	.00	-.01
35	-	-	0.00	.00	.00	.00	.00	-.01
40	-	-	-	0.00	.00	.00	.01	-.01
45	-	-	-	-	0.00	.00	.01	-.01
50	-	-	-	-	-	0.00	.00	-.01
55	-	-	-	-	-	-	0.00	-.01
60	-	-	-	-	-	-	-	0.00

TABLE VII. SUN ANGLE CORRECTION COEFFICIENT TABLES FOR MAY EMPIRICAL DATA SET (AVERAGE DIRECTIONAL REFLECTANCE)

(A) Alpha Table
Wavelength = 0.55 micrometers

θ_1 θ_2	20	25	30	35	40	45	50	55
20	1.00	.90	.83	.73	.65	.56	.48	.39
25	-	1.00	.91	.81	.72	.62	.53	.44
30	-	-	1.00	.90	.79	.69	.58	.48
35	-	-	-	1.00	.88	.76	.65	.54
40	-	-	-	-	1.00	.87	.74	.61
45	-	-	-	-	-	1.00	.85	.70
50	-	-	-	-	-	-	1.00	.83
55	-	-	-	-	-	-	-	1.00

(B) Beta Table
Wavelength = 0.55 micrometers

θ_1 θ_2	20	25	30	35	40	45	50	55
20	0.00	.03	-.04	.02	.06	.16	.25	.30
25	-	0.00	-.07	-.01	.04	.14	.23	.36
30	-	-	0.00	.06	.10	.19	.28	.40
35	-	-	-	0.00	.04	.14	.24	.37
40	-	-	-	-	0.00	.11	.20	.34
45	-	-	-	-	-	0.00	.12	.27
50	-	-	-	-	-	-	0.00	.17
55	-	-	-	-	-	-	-	0.00

(C) Alpha Table
Wavelength = 0.65 micrometers

θ_1 θ_2	20	25	30	35	40	45	50	55
20	1.00	.87	.78	.68	.57	.49	.38	.30
25	-	1.00	.90	.78	.66	.56	.43	.35
30	-	-	1.00	.86	.73	.62	.48	.39
35	-	-	-	1.00	.84	.72	.56	.45
40	-	-	-	-	1.00	.86	.66	.53
45	-	-	-	-	-	1.00	.77	.62
50	-	-	-	-	-	-	1.00	.81
55	-	-	-	-	-	-	-	1.00

May - Directional

(D) Beta Table
Wavelength = 0.65 micrometers

θ_1 \ θ_2	20	25	30	35	40	45	50	55
20	0.00	.06	.02	.09	.13	.18	.26	.32
25	-	0.00	-.03	.04	.09	.15	.24	.30
30	-	-	0.00	.06	.12	.16	.25	.31
35	-	-	-	0.00	.06	.17	.22	.28
40	-	-	-	-	0.00	.06	.18	.25
45	-	-	-	-	-	0.00	.13	.21
50	-	-	-	-	-	-	0.00	.10
55	-	-	-	-	-	-	-	0.00

(E) Alpha Table
Wavelength = 0.75 micrometers

θ_1 \ θ_2	20	25	30	35	40	45	50	55
20	1.00	.94	.88	.81	.74	.66	.59	.51
25	-	1.00	.93	.86	.78	.71	.62	.54
30	-	-	1.00	.92	.84	.76	.67	.58
35	-	-	-	1.00	.91	.82	.73	.63
40	-	-	-	-	1.00	.90	.80	.70
45	-	-	-	-	-	1.00	.88	.77
50	-	-	-	-	-	-	1.00	.87
55	-	-	-	-	-	-	-	1.00

(F) Beta Table
Wavelength = 0.75 micrometers

θ_1 \ θ_2	20	25	30	35	40	45	50	55
20	0.00	-.02	-.05	-.05	-.05	-.03	-.01	.03
25	-	0.00	-.03	-.03	-.03	-.01	.01	.04
30	-	-	0.00	.00	.00	.01	.03	.06
35	-	-	-	0.00	.00	.01	.03	.06
40	-	-	-	-	0.00	.01	.03	.06
45	-	-	-	-	-	0.00	.02	.05
50	-	-	-	-	-	-	0.00	.03
55	-	-	-	-	-	-	-	0.00

(G) Alpha Table
Wavelength = 0.95 micrometers

θ_1 \ θ_2	20	25	30	35	40	45	50	55
20	1.00	.95	.90	.83	.77	.70	.63	.55
25	-	1.00	.94	.88	.81	.74	.66	.58
30	-	-	1.00	.93	.86	.78	.70	.61
35	-	-	-	1.00	.92	.84	.75	.66
40	-	-	-	-	1.00	.91	.81	.71
45	-	-	-	-	-	1.00	.90	.79
50	-	-	-	-	-	-	1.00	.88
55	-	-	-	-	-	-	-	1.00

(H) Beta Table
Wavelength = 0.95 micrometers

θ_1 \ θ_2	20	25	30	35	40	45	50	55
20	0.00	-.01	-.02	-.02	-.02	-.02	-.01	.01
25	-	0.00	-.01	-.01	-.02	-.01	.00	.01
30	-	-	0.00	.00	-.01	.00	.01	.02
35	-	-	-	0.00	.00	.00	.01	.02
40	-	-	-	-	0.00	.00	.01	.02
45	-	-	-	-	-	0.00	.01	.02
50	-	-	-	-	-	-	0.00	.01
55	-	-	-	-	-	-	-	0.00

TABLE VIII. SUN ANGLE CORRECTION COEFFICIENT TABLES FOR JUNE EMPIRICAL DATA SET (AVERAGE DIRECTIONAL REFLECTANCE)

(A) Alpha Table
Wavelength = 0.55 micrometers

θ_1 \ θ_2	15	20	25	30	35	40	45	50
15	1.00	.94	.87	.79	.73	.65	.56	.49
20	-	1.00	.93	.84	.78	.69	.60	.52
25	-	-	1.00	.91	.84	.74	.64	.56
30	-	-	-	1.00	.92	.81	.71	.62
35	-	-	-	-	1.00	.88	.77	.67
40	-	-	-	-	-	1.00	.87	.76
45	-	-	-	-	-	-	1.00	.88
50	-	-	-	-	-	-	-	1.00

(B) Beta Table
Wavelength = 0.55 micrometers

θ_1 \ θ_2	15	20	25	30	35	40	45	50
15	0.00	-.23	-.27	-.31	-.28	-.21	-.08	.00
20	-	0.00	-.05	-.12	-.10	-.05	.06	.12
25	-	-	0.00	-.07	-.06	-.01	.09	.15
30	-	-	-	0.00	.01	.05	.14	.20
35	-	-	-	-	0.00	.04	.14	.19
40	-	-	-	-	-	0.00	.10	.16
45	-	-	-	-	-	-	0.00	.07
50	-	-	-	-	-	-	-	0.00

(C) Alpha Table
Wavelength = 0.65 micrometers

θ_1 \ θ_2	15	20	25	30	35	40	45	50
15	1.00	.96	.89	.78	.72	.70	.70	.64
20	-	1.00	.93	.82	.76	.73	.73	.67
25	-	-	1.00	.88	.81	.79	.79	.72
30	-	-	-	1.00	.92	.90	.89	.82
35	-	-	-	-	1.00	.97	.97	.89
40	-	-	-	-	-	1.00	.98	.92
45	-	-	-	-	-	-	1.00	.92
50	-	-	-	-	-	-	-	1.00

(D) Beta Table
Wavelength = 0.65 micrometers

θ_1 \ θ_2	15	20	25	30	35	40	45	50
15	0.00	-.12	-.14	-.12	-.11	-.18	-.24	-.22
20	-	0.00	-.02	-.02	-.02	-.09	-.15	-.14
25	-	-	0.00	.00	.00	-.07	-.13	-.12
30	-	-	-	0.00	.00	-.07	-.13	-.12
35	-	-	-	-	0.00	-.06	-.13	-.12
40	-	-	-	-	-	0.00	-.06	-.06
45	-	-	-	-	-	-	0.00	.00
50	-	-	-	-	-	-	-	0.00

(E) Alpha Table
Wavelength = 0.75 micrometers

θ_1 \ θ_2	15	20	25	30	35	40	45	50
15	1.00	.96	.92	.87	.82	.75	.69	.61
20	-	1.00	.96	.91	.85	.78	.71	.64
25	-	-	1.00	.95	.89	.81	.74	.67
30	-	-	-	1.00	.94	.86	.79	.70
35	-	-	-	-	1.00	.91	.84	.75
40	-	-	-	-	-	1.00	.91	.82
45	-	-	-	-	-	-	1.00	.89
50	-	-	-	-	-	-	-	1.00

(F) Beta Table
Wavelength = 0.75 micrometers

θ_1 \ θ_2	15	20	25	30	35	40	45	50
15	0.00	-.06	-.09	-.13	-.13	-.12	-.10	-.08
20	-	0.00	-.03	-.07	-.08	-.08	-.06	-.04
25	-	-	0.00	-.04	-.05	-.05	-.04	-.02
30	-	-	-	0.00	-.01	-.01	-.01	.01
35	-	-	-	-	0.00	-.01	.00	.01
40	-	-	-	-	-	0.00	.01	.02
45	-	-	-	-	-	-	0.00	.01
50	-	-	-	-	-	-	-	0.00

TABLE IX. SUN ANGLE CORRECTION COEFFICIENT TABLES FOR MARCH (MODEL DERIVED CANOPY REFLECTANCE)

ALPHA TABLE
WAVELENGTH= .55

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	1.00	1.02	1.04	1.11	1.16	1.20	1.19	1.19	1.17	1.10	1.05	1.11	1.03	.93
10.	.98	1.00	1.01	1.08	1.14	1.17	1.16	1.16	1.14	1.07	1.02	1.08	1.01	.91
15.	.96	.99	1.00	1.07	1.12	1.16	1.15	1.15	1.12	1.06	1.01	1.07	.99	.90
20.	.90	.92	.94	1.00	1.05	1.08	1.07	1.07	1.05	.99	.95	1.00	.93	.84
25.	.86	.88	.89	.95	1.00	1.03	1.02	1.02	1.00	.94	.90	.95	.89	.80
30.	.83	.85	.86	.92	.97	1.00	.99	.99	.9?	.91	.87	.92	.86	.78
35.	.84	.86	.87	.93	.98	1.01	1.00	1.00	.98	.92	.88	.93	.87	.78
40.	[illegible]	.86	.87	.93	.98	1.01	1.00	1.00	.98	.92	.88	.93	.87	.79
45.	.86	.88	.89	.95	1.00	1.03	1.02	1.02	1.00	.94	.90	.95	.88	.80
50.	.91	.93	.95	1.01	1.06	1.10	1.09	1.08	1.06	1.00	.96	1.01	.94	.85
55.	.95	.98	.99	1.06	1.11	1.15	1.14	1.13	1.1?	1.05	1.00	1.06	.98	.89
60.	.90	.92	.94	1.00	1.05	1.09	1.08	1.07	1.05	.99	.95	1.00	.93	.84
65.	.97	.99	1.01	1.07	1.13	1.17	1.15	1.15	1.1?	1.06	1.02	1.07	1.00	.91
70.	1.07	1.10	1.11	1.19	1.25	1.29	1.27	1.27	1.25	1.17	1.12	1.18	1.10	1.06

BETA TABLE
WAVELENGTH= .55

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	0.00	-.98	-1.62	-2.36	-2.86	-3.33	-3.44	-3.63	-3.65	-3.47	-3.34	-3.71	-3.43	-3.05
10.	.96	0.00	-.62	-1.30	-1.74	-2.17	-2.30	-2.48	-2.5?	-2.42	-2.33	-2.65	-2.43	-2.15
15.	1.56	.61	0.00	-.64	-1.04	-1.45	-1.59	-1.77	-1.8?	-1.76	-1.71	-1.99	-1.82	-1.59
20.	2.13	1.20	.59	0.00	-.38	-.76	-.90	-1.09	-1.1?	-1.13	-1.11	-1.35	-1.23	-1.06
25.	2.45	1.53	.93	.36	0.00	-.38	-.52	-.71	-.7?	-.78	-.77	-.99	-.89	-.75
30.	2.77	1.85	1.25	.70	.36	0.00	-.15	-.33	-.4?	-.43	-.44	-.65	-.57	-.46
35.	2.89	1.97	1.38	.84	.51	.15	0.00	-.19	-.26	-.30	-.31	-.51	-.44	-.35
40.	3.05	2.14	1.55	1.02	.69	.34	.19	0.00	-.11	-.13	-.15	-.34	-.28	-.20
45.	3.13	2.22	1.63	1.11	.79	.44	.28	.10	0.00	-.04	-.06	-.24	-.20	-.12
50.	3.16	2.25	1.67	1.14	.83	.48	.33	.14	.04	0.00	-.02	-.21	-.16	-.09
55.	3.19	2.28	1.69	1.17	.85	.50	.35	.17	.0?	.03	0.00	-.18	-.14	-.07
60.	3.35	2.45	1.86	1.35	1.04	.70	.55	.36	.26	.21	.17	0.00	.03	.08
65.	3.32	2.42	1.83	1.32	1.01	.67	.51	.33	.2?	.17	.14	-.03	0.00	.06
70.	3.26	2.35	1.77	1.25	.94	.59	.44	.25	.15	.11	.08	-.10	-.06	0.00

ALPHA TABLE
WAVELENGTH= .65

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	1.00	.99	.97	1.07	1.11	1.14	1.15	1.14	1.11	1.01	.97	1.04	.96	.88
10.	1.01	1.00	.98	1.08	1.13	1.15	1.16	1.16	1.13	1.02	.98	1.05	.97	.89
15.	1.03	1.02	1.00	1.10	1.15	1.18	1.19	1.18	1.15	1.04	1.00	1.07	.99	.91
20.	.93	.92	.91	1.00	1.04	1.07	1.08	1.07	1.04	.94	.91	.97	.90	.82
25.	.90	.89	.87	.96	1.00	1.02	1.03	1.03	1.00	.91	.87	.93	.86	.79
30.	.88	.87	.85	.94	.98	1.00	1.01	1.00	.98	.88	.85	.91	.84	.77
35.	.87	.86	.84	.93	.97	.99	1.00	.99	.97	.88	.84	.90	.83	.77
40.	.88	.86	.85	.94	.97	1.00	1.01	1.00	.98	.88	.85	.91	.84	.77
45.	.90	.89	.87	.96	1.00	1.02	1.03	1.03	1.00	.90	.87	.93	.86	.79
50.	.99	.98	.96	1.06	1.10	1.13	1.14	1.13	1.11	1.00	.96	1.03	.95	.87
55.	1.03	1.02	1.00	1.10	1.15	1.17	1.18	1.18	1.15	1.04	1.00	1.07	.99	.91
60.	.96	.95	.93	1.03	1.07	1.10	1.11	1.10	1.07	.97	.93	1.00	[illegible]	.85
65.	1.04	1.03	1.01	1.11	1.16	1.19	1.20	1.19	1.16	1.05	1.01	1.08	1.00	.92
70.	1.13	1.12	1.10	1.21	1.26	1.29	1.31	1.30	1.26	1.14	1.10	1.18	1.09	1.00

BETA TABLE
WAVELENGTH= .65

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	0.00	-.28	-.46	-.87	-1.08	-1.28	-1.39	-1.47	-1.48	-1.32	-1.29	-1.48	-1.34	-1.21
10.	.28	0.00	-.19	-.56	-.76	-.96	-1.06	-1.14	-1.16	-1.04	-1.01	-1.18	-1.07	-.95
15.	.48	.12	0.00	-.35	-.54	-.74	-.84	-.92	-.94	-.84	-.82	-.98	-.88	-.78
20.	.81	.52	.32	0.00	-.17	-.36	-.46	-.54	-.57	-.51	-.50	-.64	-.56	-.49
25.	.97	.67	.47	.17	0.00	-.18	-.28	-.36	-.40	-.35	-.35	-.47	-.41	-.35
30.	1.12	.83	.62	.34	.18	0.00	-.09	-.18	-.22	-.19	-.20	-.31	-.26	-.21
35.	1.21	.91	.70	.42	.27	.09	0.00	-.09	-.13	-.10	-.12	-.22	-.18	-.14
40.	1.28	.99	.76	.51	.35	.18	.09	0.00	-.04	-.03	-.04	-.14	-.11	-.07
45.	1.32	1.03	.82	.55	.40	.23	.13	.05	0.00	.01	-.00	-.10	-.07	-.04
50.	1.31	1.01	.81	.54	.38	.21	.12	.03	-.01	0.00	-.02	-.12	-.08	-.05
55.	1.33	1.03	.82	.55	.40	.23	.14	.05	.00	.02	0.00	-.10	-.07	-.04
60.	1.42	1.13	.91	.66	.51	.34	.25	.16	.11	.11	.09	0.00	.03	.05
65.	1.40	1.10	.89	.63	.48	.31	.22	.13	.08	.09	.07	-.03	0.00	.03
70.	1.37	1.07	.86	.60	.45	.28	.18	.09	.05	.06	.04	-.06	-.03	0.00

ALPHA TABLE
WAVELENGTH= .75

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	1.00	1.03	1.05	1.14	1.22	1.25	1.27	1.27	1.24	1.21	1.17	1.25	1.20	1.11
10.	.97	1.00	1.02	1.11	1.18	1.21	1.23	1.23	1.20	1.17	1.13	1.21	1.17	1.07
15.	.95	.98	1.00	1.08	1.15	1.19	1.20	1.20	1.18	1.15	1.11	1.18	1.14	1.05
20.	.87	.90	.92	1.00	1.06	1.09	1.11	1.11	1.08	1.06	1.02	1.09	1.05	.97
25.	.82	.85	.87	.94	1.00	1.03	1.04	1.04	1.02	.99	.96	1.03	.99	.91
30.	.86	.82	.84	.91	.97	1.00	1.01	1.01	.99	.97	.93	1.00	.96	.89
35.	.79	.81	.83	.90	.96	.99	1.00	1.00	.98	.96	.92	.99	.95	.87
40.	.79	.81	.83	.90	.96	.99	1.00	1.00	.98	.95	.92	.98	.95	.87
45.	.81	.83	.85	.92	.98	1.01	1.02	1.02	1.00	.98	.94	1.01	.97	.89
50.	.83	.85	.87	.95	1.01	1.03	1.05	1.05	1.03	1.00	.97	1.03	.99	.92
55.	.86	.88	.90	.98	1.04	1.07	1.08	1.09	1.06	1.04	1.00	1.07	1.03	.95
60.	.80	.83	.84	.92	.97	1.00	1.01	1.02	.99	.97	.94	1.00	.96	.89
65.	.83	.86	.88	.95	1.01	1.04	1.05	1.05	1.03	1.01	.97	1.04	1.00	.92
70.	.90	.93	.95	1.03	1.10	1.13	1.14	1.14	1.12	1.09	1.05	1.13	1.08	1.00

BETA TABLE
WAVELENGTH= .75

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	0.00	-.16	-.28	-.46	-.60	-.71	-.78	-.83	-.83	-.84	-.82	-.92	-.89	-.80
10.	.15	0.00	-.12	-.29	-.41	-.52	-.58	-.63	-.64	-.65	-.64	-.73	-.70	-.63
15.	.26	.11	0.00	-.16	-.28	-.38	-.44	-.49	-.51	-.52	-.51	-.59	-.57	-.51
20.	.40	.26	.15	0.00	-.11	-.21	-.26	-.32	-.33	-.35	-.34	-.42	-.40	-.35
25.	.49	.35	.24	.10	0.00	-.10	-.15	-.20	-.22	-.24	-.24	-.31	-.29	-.26
30.	.57	.43	.32	.19	.09	0.00	-.05	-.10	-.13	-.15	-.15	-.21	-.20	-.17
35.	.61	.47	.37	.24	.15	.05	0.00	-.05	-.07	-.10	-.10	-.16	-.15	-.12
40.	.65	.52	.41	.28	.19	.10	.05	0.00	-.02	-.05	-.05	-.11	-.10	-.08
45.	.67	.54	.43	.31	.22	.13	.08	.02	0.00	-.02	-.03	-.08	-.08	-.06
50.	.69	.56	.45	.33	.24	.15	.10	.05	.02	0.00	-.01	-.06	-.05	-.03
55.	.70	.55	.46	.34	.25	.16	.11	.06	.03	.01	0.00	-.05	-.05	-.03
60.	.74	.61	.50	.38	.30	.21	.16	.11	.08	.06	.05	0.00	.00	.02
65.	.74	.60	.50	.38	.30	.21	.16	.11	.08	.06	.05	-.00	0.00	.02
70.	.72	.59	.48	.37	.28	.19	.14	.09	.06	.04	.03	-.02	-.02	0.00

ALPHA TABLE
WAVELENGTH= .95

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	1.00	1.04	1.06	1.14	1.21	1.24	1.25	1.25	1.2[illegible]	1.20	1.16	1.23	1.19	1.10
10.	.97	1.00	1.02	1.10	1.17	1.19	1.21	1.20	1.1[illegible]	1.16	1.12	1.19	1.15	1.06
15.	.95	.98	1.00	1.08	1.14	1.17	1.18	1.18	1.1[illegible]	1.13	1.10	1.17	1.12	1.04
20.	.87	.91	.92	1.00	1.06	1.08	1.09	1.09	1.0[illegible]	1.05	1.02	1.08	1.04	.96
25.	.83	.86	.87	.95	1.00	1.02	1.03	1.03	1.0[illegible]	.99	.96	1.02	.96	.91
30.	.81	.84	.85	.92	.98	1.00	1.01	1.01	.9[illegible]	.97	.94	1.00	.96	.89
35.	.80	.83	.85	.92	.97	.99	1.00	1.00	.9[illegible]	.96	.93	.99	.95	.88
40.	.80	.83	.85	.92	.97	.99	1.00	1.00	.9[illegible]	.96	.93	.99	.95	.88
45.	[illegible]	.84	.86	.93	.99	1.01	1.02	1.02	1.0[illegible]	.98	.95	1.01	.97	.90
50.	.8[illegible]	.86	.88	.95	1.01	1.03	1.04	1.04	1.0[illegible]	1.00	.97	1.03	.99	.92
55.	.86	.89	.91	.98	1.04	1.07	1.07	1.07	1.0[illegible]	1.03	1.00	1.06	1.02	.95
60.	.81	.84	.86	.93	.98	1.00	1.01	1.01	.9[illegible]	.97	.94	1.00	.96	.89
65.	.84	.87	.89	.96	1.02	1.04	1.05	1.05	1.0[illegible]	1.01	.98	1.04	1.00	.93
70.	.91	.94	.96	1.04	1.10	1.12	1.13	1.13	1.11	1.09	1.06	1.12	1.08	1.00

BETA TABLE
WAVELENGTH= .95

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	0.00	-.05	-.08	-.14	-.18	-.22	-.24	-.26	-.26	-.26	-.26	-.29	-.28	-.25
10.	.04	0.00	-.03	-.09	-.13	-.15	-.18	-.20	-.21	-.21	-.21	-.24	-.22	-.20
15.	.07	.03	0.00	-.05	-.09	-.13	-.15	-.15	-.17	-.17	-.17	-.20	-.19	-.16
20.	.12	.08	.05	0.00	-.04	-.07	-.00	-.11	-.11	-.12	-.12	-.14	-.13	-.11
25.	.15	.11	.08	.03	0.00	-.03	-.05	-.07	-.08	-.08	-.08	-.10	-.10	-.08
30.	.18	.14	.11	.07	.03	0.00	-.02	-.04	-.05	-.05	-.05	-.07	-.07	-.05
35.	.19	.15	.12	.08	.05	.02	0.00	-.02	-.03	-.03	-.03	-.05	-.05	-.04
40.	.21	.17	.14	.10	.07	.04	.02	0.00	-.01	-.02	-.02	-.04	-.03	-.02
45.	.21	.18	.15	.11	.08	.05	.03	.01	0.00	-.01	-.01	-.03	-.02	-.01
50.	.22	.18	.15	.11	.08	.05	.04	.02	.01	0.00	-.00	-.02	-.01	-.00
55.	.22	.18	.16	.12	.09	.06	.04	.02	.01	.00	0.00	-.02	-.01	-.00
60.	.24	.20	.17	.13	.10	.07	.05	.04	.03	.02	.02	0.00	.00	.01
65.	.23	.19	.17	.13	.10	.07	.05	.03	.02	.01	.01	-.00	0.00	.01
70.	.22	.19	.16	.12	.09	.06	.04	.02	.01	.00	.00	-.01	-.01	0.00

TABLE X. SUN ANGLE CORRECTION COEFFICIENT TABLES FOR APRIL (MODEL DERIVED CANOPY REFLECTANCE)

ALPHA TABLE
WAVELENGTH= .55

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	1.00	1.05	1.09	1.15	1.20	1.17	1.13	1.17	1.19	1.09	1.05	1.00	.94	.85
10.	.95	1.00	1.04	1.10	1.14	1.11	1.07	1.11	1.13	1.04	1.00	.95	.90	.81
15.	.91	.96	1.00	1.05	1.10	1.07	1.03	1.07	1.09	1.00	.96	.91	.86	.78
20.	.87	.91	.95	1.00	1.04	1.01	.98	1.02	1.03	.95	.91	.87	.82	.74
25.	.83	.88	.91	.96	1.00	.98	.94	.98	.99	.91	.88	.83	.79	.71
30.	.86	.90	.94	.99	1.02	1.00	.96	1.00	1.02	.93	.90	.86	.81	.73
35.	.89	.93	.97	1.02	1.06	1.04	1.00	1.04	1.05	.97	.93	.89	.84	.76
40.	.85	.90	.93	.98	1.02	1.00	.96	1.00	1.01	.93	.90	.85	.81	.73
45.	.84	.88	.92	.97	1.01	.98	.95	.99	1.00	.92	.89	.84	.79	.72
50.	.92	.96	1.00	1.06	1.10	1.07	1.03	1.07	1.09	1.00	.97	.92	.86	.78
55.	.95	1.00	1.04	1.09	1.14	1.11	1.07	1.11	1.13	1.04	1.00	.95	.90	.81
60.	1.00	1.05	1.09	1.15	1.20	1.17	1.13	1.17	1.19	1.09	1.06	1.00	.94	.85
65.	1.06	1.11	1.16	1.22	1.27	1.24	1.19	1.24	1.25	1.16	1.12	1.06	1.00	.90
70.	1.17	1.23	1.28	1.35	1.40	1.37	1.32	1.37	1.39	1.28	1.24	1.17	1.11	1.00

BETA TABLE
WAVELENGTH= .55

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	0.00	-1.11	-1.87	-2.57	-3.01	-3.18	-3.15	-3.55	-3.75	-3.45	-3.37	-3.22	-3.03	-2.68
10.	1.06	0.00	-.71	-1.35	-1.74	-1.94	-1.96	-2.31	-2.47	-2.29	-2.25	-2.16	-2.03	-1.78
15.	1.71	.69	0.00	-.59	-.96	-1.17	-1.22	-1.54	-1.72	-1.58	-1.56	-1.51	-1.41	-1.22
20.	2.23	1.23	.56	0.00	-.34	-.57	-.64	-.94	-1.11	-1.02	-1.02	-1.00	-.93	-.78
25.	2.51	1.53	.88	.33	0.00	-.24	-.32	-.60	-.77	-.70	-.72	-.71	-.65	-.53
30.	2.72	1.74	1.10	.57	.24	0.00	-.09	-.36	-.52	-.48	-.50	-.50	-.46	-.36
35.	2.80	1.83	1.19	.66	.34	.09	0.00	-.27	-.43	-.39	-.42	-.42	-.39	-.29
40.	3.02	2.07	1.44	.92	.61	.36	.26	0.00	-.15	-.14	-.18	-.20	-.17	-.10
45.	3.16	2.21	1.58	1.07	.77	.52	.41	.16	0.01	.00	-.04	-.06	-.05	.02
50.	3.16	2.21	1.58	1.07	.77	.52	.41	.15	-.01	0.00	-.04	-.06	-.05	.02
55.	3.19	2.25	1.62	1.12	.82	.56	.45	.20	[illegible]	.04	0.00	-.03	-.01	.05
60.	3.22	2.27	1.65	1.15	.85	.59	.48	.23	.03	.07	.03	0.00	.01	.07
65.	3.21	2.26	1.63	1.13	.83	.57	.46	.21	.00	.05	.01	-.02	0.00	.06
70.	3.14	2.19	1.56	1.05	.75	.49	.39	.13	[illegible]	-.02	-.06	-.08	-.06	0.00

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ALPHA TABLE
WAVELENGTH= .65

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	1.00	1.08	1.11	1.17	1.21	1.20	1.17	1.23	1.23	1.15	1.10	1.04	1.01	.94
10.	.92	1.00	1.02	1.08	1.12	1.10	1.08	1.14	1.14	1.06	1.01	.96	.93	.87
15.	.90	.98	1.00	1.05	1.09	1.08	1.05	1.11	1.12	1.04	.99	.94	.91	.85
20.	.86	.93	.95	1.00	1.04	1.03	1.00	1.06	1.06	.98	.94	.89	.86	.81
25.	.83	.89	.92	.96	1.00	.99	.96	1.02	1.02	.95	.91	.86	.83	.78
30.	.84	.91	.93	.98	1.01	1.00	.98	1.03	1.03	.96	. 2	.87	.84	.79
35.	.86	.93	.95	1.00	1.04	1.02	1.00	1.06	1.06	.98	.94	.89	.86	.80
40.	.81	.88	.90	.95	.98	.97	.95	1.00	1.00	.93	.89	.84	.82	.76
45.	.81	.88	.90	.94	.98	.97	.94	1.00	1.00	.93	.89	.84	.82	.76
50.	.87	.94	.96	1.02	1.05	1.04	1.02	1.07	1.08	1.00	.96	.91	.88	.82
55.	.91	.99	1.01	1.06	1.10	1.09	1.06	1.12	1.12	1.04	1.00	.95	.92	.86
60.	.96	1.04	1.06	1.12	1.16	1.15	1.12	1.18	1.18	1.10	1.05	1.00	.97	.90
65.	.99	1.08	1.10	1.16	1.20	1.19	1.16	1.23	1.23	1.14	1.09	1.04	1.00	.93
70.	1.06	1.15	1.18	1.24	1.29	1.27	1.24	1.31	1.31	1.22	1.17	1.11	1.07	1.00

BETA TABLE
WAVELENGTH= .65

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	0.00	-.48	-.75	-1.07	-1.28	-1.40	-1.42	-1.66	-1.73	-1.61	-1.55	-1.49	-1.44	-1.33
10.	.44	0.00	-.27	-.55	-.74	-.87	-.91	-1.11	-1.18	-1.11	-1.07	-1.03	-.99	-.91
15.	.68	.26	0.00	-.27	-.45	-.58	-.63	-.82	-.89	-.83	-.81	-.78	-.75	-.69
20.	.91	.51	.26	0.00	-.17	-.30	-.36	-.53	-.60	-.56	-.55	-.53	-.52	-.47
25.	1.06	.67	.42	.16	0.00	-.13	-.19	-.36	-.42	-.40	-.39	-.39	-.37	-.33
30.	1.17	.79	.54	.30	.14	0.00	-.06	-.22	-.28	-.27	-.27	-.27	-.26	-.23
35.	1.22	.84	.60	.35	.20	.06	0.00	-.15	-.22	-.21	-.21	-.22	-.21	-.18
40.	1.34	.98	.73	.50	.35	.21	.15	0.00	-.07	-.07	-.08	-.09	-.09	-.06
45.	1.40	1.04	.79	.56	.41	.27	.21	.07	0.00	-.01	-.02	-.03	-.03	-.01
50.	1.40	1.04	.80	.57	.42	.28	.22	.08	.01	0.00	-.01	-.02	-.02	-.01
55.	1.41	1.05	.81	.58	.43	.29	.23	.09	.02	.01	0.00	-.01	-.01	.00
60.	1.43	1.07	.83	.60	.45	.31	.24	.10	.03	.02	.01	0.00	-.00	.01
65.	1.43	1.07	.83	.60	.45	.31	.24	.10	.04	.03	.01	.00	0.00	.02
70.	1.41	1.05	.81	.58	.43	.29	.22	.08	.02	.01	-.00	-.01	-.02	0.00

ALPHA TABLE
WAVELENGTH= .75

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	1.00	1.07	1.12	1.17	1.21	1.20	1.17	1.21	1.22	1.14	1.11	1.05	1.02	.95
10.	.94	1.00	1.05	1.10	1.13	1.12	1.09	1.13	1.14	1.07	1.04	.99	.96	.89
15.	.89	.95	1.00	1.05	1.08	1.07	1.04	1.08	1.09	1.02	.99	.94	.91	.85
20.	.85	.91	.95	1.00	1.03	1.02	.99	1.03	1.04	.97	.94	.90	.87	.81
25.	.83	.88	.92	.97	1.00	.99	.96	1.00	1.01	.94	.91	.87	.84	.79
30.	.84	.89	.93	.98	1.01	1.00	.97	1.01	1.02	.95	.92	.88	.85	.79
35.	.86	.92	.96	1.01	1.04	1.03	1.00	1.03	1.05	.98	.95	.90	.87	.81
40.	.83	.88	.93	.97	1.00	.99	.97	1.00	1.01	.95	.92	.87	.84	.79
45.	.82	.87	.92	.96	.99	.98	.96	.99	1.0[illegible]	.94	.91	.86	.84	.78
50.	.88	.94	.98	1.03	1.06	1.05	1.02	1.06	1.07	1.00	.97	.92	.89	.83
55.	.90	.97	1.01	1.06	1.09	1.08	1.05	1.09	1.1[illegible]	1.03	1.00	.95	.92	.86
60.	.95	1.01	1.06	1.11	1.15	1.14	1.11	1.15	1.15	1.08	1.05	1.00	.97	.90
65.	.98	1.05	1.10	1.15	1.19	1.17	1.14	1.18	1.2[illegible]	1.12	1.08	1.03	1.00	.93
70.	1.05	1.12	1.18	1.24	1.27	1.26	1.23	1.27	1.2[illegible]	1.20	1.16	1.11	1.07	1.00

BETA TABLE
WAVELENGTH= .75

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	0.00	-.19	-.34	-.49	-.59	-.66	-.67	-.76	-.8[illegible]	-.76	-.75	-.72	-.70	-.64
10.	.18	0.00	-.14	-.28	-.37	-.44	-.46	-.54	-.5[illegible]	-.56	-.55	-.53	-.51	-.46
15.	.31	.13	0.00	-.13	-.22	-.29	-.31	-.39	-.4[illegible]	-.41	-.41	-.40	-.38	-.34
20.	.42	.25	.13	0.00	-.08	-.16	-.18	-.26	-.3[illegible]	-.29	-.29	-.28	-.27	-.24
25.	.49	.33	.20	.08	0.00	-.07	-.10	-.17	-.2[illegible]	-.21	-.21	-.20	-.20	-.17
30.	.55	.39	.27	.15	.07	0.00	-.03	-.10	-.1[illegible]	-.14	-.14	-.14	-.14	-.11
35.	.57	.42	.30	.18	.10	.03	0.00	-.07	-.11	-.11	-.11	-.11	-.11	-.09
40.	.63	.48	.36	.25	.17	.10	.07	0.00	-.0[illegible]	-.04	-.05	-.05	-.05	-.04
45.	.66	.52	.40	.29	.21	.14	.11	.04	0.0[illegible]	-.01	-.01	-.02	-.02	-.00
50.	.67	.52	.41	.29	.22	.15	.11	.05	.01	0.00	-.01	-.01	-.01	.00
55.	.68	.53	.41	.30	.23	.15	.12	.06	.02	.01	0.00	-.01	-.00	.01
60.	.69	.54	.42	.31	.24	.16	.13	.06	.02	.02	.01	0.00	.00	.01
65.	.68	.53	.42	.31	.23	.16	.13	.06	.02	.01	.00	-.00	0.00	.01
70.	.67	.52	.41	.29	.22	.14	.11	.04	.0[illegible]	-.00	-.01	-.01	-.01	0.00

ALPHA TABLE
WAVELENGTH= .95

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	1.00	1.06	1.10	1.16	1.20	1.19	1.16	1.20	1.21	1.13	1.10	1.05	1.01	.95
10.	.95	1.00	1.04	1.09	1.13	1.12	1.10	1.13	1.14	1.07	1.04	.99	.96	.90
15.	.90	.96	1.00	1.05	1.08	1.07	1.05	1.09	1.09	1.03	.99	.95	.92	.86
20.	.86	.91	.95	1.00	1.03	1.03	1.00	1.04	1.04	.98	.95	.91	.88	.82
25.	.84	.88	.92	.97	1.00	.99	.97	1.00	1.01	.95	.92	.88	.85	.79
30.	.84	.89	.93	.97	1.01	1.00	.98	1.01	1.02	.95	.92	.88	.85	.80
35.	.86	.91	.95	1.00	1.03	1.02	1.00	1.03	1.04	.98	.94	.90	.87	.82
40.	.83	.88	.92	.96	1.00	.99	.97	1.00	1.01	.94	.91	.87	.85	.79
45.	.83	.88	.91	.96	.99	.98	.96	.99	1.00	.94	.91	.87	.84	.78
50.	.88	.93	.98	1.02	1.05	1.05	1.02	1.06	1.07	1.00	.97	.92	.90	.84
55.	.91	.96	1.01	1.05	1.09	1.08	1.06	1.09	1.10	1.03	1.00	.95	.92	.86
60.	.95	1.01	1.06	1.10	1.14	1.13	1.11	1.15	1.15	1.08	1.05	1.00	.97	.91
65.	.99	1.04	1.09	1.14	1.18	1.17	1.15	1.18	1.19	1.12	1.08	1.03	1.00	.93
70.	1.05	1.12	1.17	1.22	1.26	1.25	1.23	1.27	1.27	1.20	1.16	1.10	1.07	1.00

BETA TABLE
WAVELENGTH= .95

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	0.00	-.05	-.10	-.14	-.18	-.20	-.21	-.24	-.26	-.24	-.24	-.23	-.21	-.19
10.	.05	0.00	-.04	-.08	-.12	-.14	-.15	-.18	-.20	-.18	-.18	-.17	-.16	-.15
15.	.09	.04	0.00	-.04	-.07	-.10	-.11	-.14	-.15	-.14	-.14	-.13	-.13	-.11
20.	.12	.08	.04	0.00	-.03	-.06	-.07	-.09	-.11	-.10	-.10	-.10	-.09	-.08
25.	.15	.10	.07	.03	0.00	-.03	-.04	-.06	-.08	-.07	-.07	-.07	-.06	-.05
30.	.17	.13	.09	.05	.03	0.00	-.01	-.04	-.05	-.05	-.05	-.05	-.04	-.03
35.	.18	.14	.10	.07	.04	.01	0.00	-.02	-.04	-.04	-.04	-.04	-.03	-.02
40.	.20	.16	.13	.09	.06	.04	.02	0.00	-.01	-.01	-.01	-.01	-.01	-.00
45.	.21	.17	.14	.10	.08	.05	.04	.01	0.00	-.00	-.00	-.00	.00	.01
50.	.21	.17	.14	.10	.08	.05	.04	.01	.00	0.00	-.00	-.00	.00	.01
55.	.21	.17	.14	.11	.08	.05	.04	.02	.00	.00	0.00	-.00	.00	.01
60.	.21	.17	.14	.11	.08	.05	.04	.02	.00	.00	.00	0.00	.00	.01
65.	.21	.17	.14	.10	.08	.05	.04	.01	-.00	-.00	-.00	-.00	0.00	.01
70.	.20	.16	.13	.09	.07	.04	.03	.00	-.01	-.01	-.01	-.01	-.01	0.00

TABLE XI. SUN ANGLE CORRECTION COEFFICIENT TABLES FOR MAY (MODEL DERIVED CANOPY REFLECTANCE)

ALPHA TABLE
WAVELENGTH= .55

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	1.00	1.03	1.05	1.15	1.18	1.24	1.31	1.28	1.24	1.25	1.20	1.16	1.10	1.03
10.	.97	1.00	1.02	1.11	1.15	1.20	1.27	1.25	1.20	1.22	1.17	1.13	1.07	1.00
15.	.95	.98	1.00	1.09	1.12	1.18	1.24	1.22	1.18	1.19	1.14	1.10	1.05	.98
20.	.87	.90	.92	1.00	1.03	1.08	1.14	1.12	1.08	1.10	1.05	1.01	.96	.90
25.	.85	.87	.89	.97	1.00	1.05	1.11	1.09	1.05	1.06	1.02	.98	.93	.87
30.	.81	.83	.85	.92	.95	1.00	1.06	1.04	1.00	1.01	.97	.94	.89	.83
35.	.76	.79	.80	.87	.90	.95	1.00	.98	.95	.96	.92	.89	.84	.79
40.	.78	.80	.82	.89	.92	.96	1.02	1.00	.96	.98	.94	.90	.86	.80
45.	.81	.83	.85	.92	.95	1.00	1.06	1.04	1.00	1.01	.97	.94	.89	.83
50.	.80	.82	.84	.91	.94	.99	1.04	1.02	.99	1.00	.96	.93	.88	.82
55.	.83	.86	.87	.95	.98	1.03	1.09	1.07	1.03	1.04	1.00	.96	.91	.85
60.	.86	.89	.91	.99	1.02	1.07	1.13	1.11	1.07	1.08	1.04	1.00	.95	.89
65.	.91	.94	.96	1.04	1.07	1.12	1.19	1.17	1.13	1.14	1.09	1.05	1.00	.93
70.	.97	1.00	1.02	1.11	1.15	1.20	1.27	1.25	1.20	1.22	1.17	1.13	1.07	1.00

BETA TABLE
WAVELENGTH= .55

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	0.00	-1.02	-1.68	-2.53	-2.93	-3.49	-3.98	-4.06	-3.98	-4.19	-4.05	-3.95	-3.74	-3.48
10.	.99	0.00	-.65	-1.40	-1.77	-2.27	-2.69	-2.79	-2.76	-2.95	-2.86	-2.81	-2.65	-2.46
15.	1.60	.63	0.00	-.70	-1.04	-1.51	-1.88	-2.00	-2.00	-2.18	-2.13	-2.10	-1.98	-1.83
20.	2.21	1.26	.64	0.00	-.32	-.76	-1.09	-1.22	-1.25	-1.42	-1.39	-1.39	-1.31	-1.21
25.	2.48	1.54	.93	.32	0.00	-.41	-.73	-.87	-.90	-1.07	-1.06	-1.07	-1.01	-.92
30.	2.82	1.89	1.28	.70	.40	0.00	-.29	-.44	-.49	-.65	-.66	-.68	-.64	-.58
35.	3.04	2.12	1.52	.95	.66	.27	0.00	-.15	-.22	-.37	-.39	-.43	-.39	-.35
40.	3.16	2.24	1.64	1.09	.80	.42	.15	0.00	-.07	-.23	-.25	-.29	-.26	-.23
45.	3.21	2.30	1.70	1.15	.86	.49	.23	.07	0.00	-.16	-.18	-.22	-.20	-.17
50.	3.34	2.42	1.83	1.29	1.01	.64	.39	.23	.15	0.00	-.03	-.08	-.07	-.04
55.	3.36	2.45	1.86	1.32	1.04	.68	.42	.27	.19	.03	0.00	-.05	-.04	-.02
60.	3.41	2.49	1.90	1.37	1.09	.73	.48	.32	.24	.09	.05	0.00	.01	.03
65.	3.40	2.49	1.89	1.36	1.08	.72	.47	.31	.23	.08	.04	-.01	0.00	.02
70.	3.38	2.47	1.07	1.34	1.06	.70	.45	.29	.21	.05	.02	-.03	-.02	0.00

ALPHA TABLE
WAVELENGTH= .65

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	1.00	1.05	1.09	1.18	1.19	1.30	1.33	1.33	1.27	1.31	1.27	1.22	1.17	1.09
10.	.95	1.00	1.04	1.12	1.13	1.24	1.26	1.27	1.21	1.25	1.21	1.16	1.11	1.04
15.	.92	.96	1.00	1.08	1.09	1.19	1.22	1.22	1.17	1.20	1.16	1.12	1.07	1.00
20.	.85	.89	.93	1.00	1.01	1.10	1.13	1.13	1.03	1.11	1.08	1.03	.99	.93
25.	.84	.88	.92	.99	1.00	1.09	1.11	1.12	1.07	1.10	1.06	1.02	.98	.92
30.	.77	.81	.84	.91	.92	1.00	1.02	1.03	.93	1.01	.97	.94	.90	.84
35.	.75	.79	.82	.89	.90	.98	1.00	1.00	.9[illegible]	.99	.95	.92	.88	.82
40.	.75	.79	.82	.88	.89	.97	1.00	1.00	.9[illegible]	.98	.95	.91	.88	.82
45.	.79	.83	.86	.93	.94	1.02	1.05	1.05	1.0[illegible]	1.03	1.00	.96	.92	.86
50.	.76	.80	.83	.90	.91	.99	1.01	1.02	.9[illegible]	1.00	.97	.93	.89	.83
55.	.79	.83	.86	.93	.94	1.03	1.05	1.05	1.0[illegible]	1.03	1.00	.96	.92	.86
60.	.82	.86	.90	.97	.98	1.07	1.09	1.10	1.0[illegible]	1.08	1.04	1.00	.96	.90
65.	.86	.90	.93	1.01	1.02	1.11	1.14	1.14	1.0[illegible]	1.12	1.08	1.04	1.00	.93
70.	.92	.96	1.00	1.08	1.09	1.19	1.22	1.22	1.1[illegible]	1.20	1.16	1.11	1.07	1.00

BETA TABLE
WAVELENGTH= .65

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	0.00	-.41	-.72	-1.09	-1.24	-1.61	-1.76	-1.87	-1.8[illegible]	-1.95	-1.90	-1.85	-1.77	-1.64
10.	.39	0.00	-.29	-.63	-.77	-1.10	-1.24	-1.34	-1.3[illegible]	-1.44	-1.41	-1.37	-1.32	-1.22
15.	.66	.28	0.00	-.32	-.45	-.76	-.88	-.99	-.9[illegible]	-1.09	-1.07	-1.05	-1.01	-.92
20.	.93	.56	.29	0.00	-.14	-.41	-.53	-.63	-.6[illegible]	-.74	-.73	-.72	-.69	-.63
25.	1.04	.68	.42	.13	0.00	-.26	-.38	-.48	-.4[illegible]	-.59	-.59	-.58	-.56	-.51
30.	1.24	.89	.64	.37	.24	0.00	-.11	-.21	-.2[illegible]	-.32	-.33	-.34	-.32	-.29
35.	1.32	.98	.73	.47	.34	.11	0.00	-.10	-.12	-.21	-.23	-.24	-.23	-.20
40.	1.40	1.06	.81	.56	.43	.20	.10	0.00	-.0[illegible]	-.12	-.13	-.15	-.14	-.12
45.	1.42	1.08	.83	.58	.45	.23	.12	.02	0.0[illegible]	-.09	-.11	-.12	-.12	-.10
50.	1.49	1.15	.90	.66	.53	.32	.22	.12	.0[illegible]	0.00	-.02	-.04	-.04	-.02
55.	1.50	1.17	.92	.68	.55	.34	.24	.14	.1[illegible]	.02	0.00	-.02	-.02	-.00
60.	1.52	1.19	.94	.70	.57	.36	.26	.16	.1[illegible]	.04	.02	0.00	.00	.02
65.	1.52	1.19	.94	.70	.57	.36	.26	.16	.1[illegible]	.04	.02	-.00	0.00	.02
70.	1.50	1.17	.92	.68	.55	.34	.24	.14	.1[illegible]	.02	.00	-.02	-.02	0.00

ALPHA TABLE
WAVELENGTH= .75

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	1.00	1.05	1.09	1.15	1.19	1.27	1.33	1.32	1.28	1.29	1.24	1.21	1.16	1.09
10.	.95	1.00	1.04	1.09	1.13	1.21	1.26	1.25	1.22	1.23	1.18	1.15	1.10	1.04
15.	.91	.96	1.00	1.05	1.08	1.16	1.21	1.21	1.17	1.18	1.14	1.10	1.06	1.00
20.	.87	.92	.95	1.00	1.03	1.11	1.16	1.15	1.12	1.13	1.09	1.05	1.01	.95
25.	.84	.89	.92	.97	1.00	1.07	1.12	1.11	1.08	1.09	1.05	1.02	.98	.92
30.	.79	.83	.86	.90	.93	1.00	1.04	1.04	1.01	1.02	.98	.95	.91	.86
35.	.75	.79	.82	.86	.89	.96	1.00	.99	.97	.97	.94	.91	.87	.82
40.	.76	.80	.83	.87	.90	.96	1.01	1.00	.97	.98	.94	.92	.88	.83
45.	.78	.82	.85	.89	.92	.99	1.03	1.03	1.00	1.01	.97	.94	.90	.85
50.	.77	.81	.85	.89	.92	.98	1.03	1.02	.99	1.00	.96	.93	.90	.84
55.	.80	.85	.88	.92	.95	1.02	1.07	1.06	1.03	1.04	1.00	.97	.93	.88
60.	.83	.87	.91	.95	.98	1.05	1.10	1.09	1.06	1.07	1.03	1.00	.96	.90
65.	.86	.91	.95	.99	1.02	1.10	1.15	1.14	1.11	1.12	1.08	1.04	1.00	.94
70.	.92	.97	1.00	1.05	1.09	1.17	1.22	1.21	1.18	1.19	1.14	1.11	1.06	1.00

BETA TABLE
WAVELENGTH= .75

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	0.00	-.18	-.32	-.46	-.57	-.73	-.84	-.88	-.88	-.92	-.89	-.88	-.84	-.78
10.	.17	0.00	-.13	-.27	-.37	-.52	-.61	-.66	-.66	-.70	-.68	-.68	-.64	-.60
15.	.29	.13	0.00	-.13	-.22	-.36	-.45	-.50	-.50	-.55	-.53	-.53	-.50	-.46
20.	.40	.25	.12	0.00	-.09	-.22	-.30	-.35	-.36	-.40	-.39	-.39	-.37	-.34
25.	.48	.32	.20	.08	0.00	-.13	-.20	-.25	-.26	-.30	-.30	-.30	-.29	-.26
30.	.58	.43	.31	.20	.12	0.00	-.07	-.12	-.14	-.18	-.18	-.18	-.17	-.15
35.	.63	.49	.37	.26	.18	.07	0.00	-.05	-.07	-.11	-.11	-.12	-.11	-.09
40.	.67	.52	.41	.30	.22	.11	.05	0.00	-.02	-.06	-.06	-.07	-.07	-.05
45.	.68	.54	.43	.32	.24	.13	.07	.02	0.00	-.04	-.04	-.05	-.05	-.04
50.	.71	.57	.46	.35	.28	.17	.11	.06	.04	0.00	-.01	-.02	-.01	-.00
55.	.72	.58	.47	.36	.29	.18	.12	.07	.04	.01	0.00	-.01	-.01	.00
60.	.73	.59	.48	.37	.30	.19	.13	.08	.06	.02	.01	0.00	.00	.01
65.	.72	.58	.47	.37	.29	.19	.12	.08	.05	.02	.01	-.00	0.00	.01
70.	.72	.58	.47	.36	.28	.18	.11	.07	.04	.00	-.00	-.01	-.01	0.00

ALPHA TABLE
WAVELENGTH= .95

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	1.00	1.05	1.08	1.14	1.18	1.26	1.31	1.30	1.[illegible]7	1.27	1.22	1.18	1.13	1.07
10.	.95	1.00	1.03	1.09	1.12	1.20	1.25	1.24	1.[illegible]0	1.21	1.16	1.13	1.08	1.02
15.	.92	.97	1.00	1.05	1.09	1.16	1.21	1.20	1.17	1.17	1.13	1.09	1.04	.98
20.	.88	.92	.95	1.00	1.03	1.10	1.15	1.14	1.11	1.11	1.07	1.04	.99	.93
25.	.85	.89	.92	.97	1.00	1.07	1.11	1.10	1.07	1.08	1.04	1.01	.96	.91
30.	.80	.84	.86	.91	.94	1.00	1.04	1.03	1.01	1.01	.97	.94	.90	.85
35.	.76	.80	.83	.87	.90	.96	1.00	.99	.97	.97	.93	.90	.86	.81
40.	.77	.81	.84	.88	.91	.97	1.01	1.00	.97	.98	.94	.91	.87	.82
45.	.79	.83	.86	.90	.93	.99	1.04	1.03	1.00	1.00	.97	.94	.89	.84
50.	.79	.83	.85	.90	.93	.99	1.03	1.02	1.00	1.00	.96	.93	.89	.84
55.	.82	.86	.89	.93	.96	1.03	1.07	1.06	1.04	1.04	1.00	.97	.93	.87
60.	.85	.89	.92	.96	.99	1.06	1.11	1.10	1.07	1.07	1.03	1.00	.96	.90
65.	.88	.93	.96	1.01	1.04	1.11	1.16	1.15	1.12	1.12	1.08	1.05	1.00	.94
70.	.94	.98	1.02	1.07	1.10	1.18	1.23	1.22	1.19	1.19	1.14	1.11	1.06	1.00

BETA TABLE
WAVELENGTH= .95

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	0.00	-.05	-.09	-.14	-.17	-.23	-.26	-.28	-.2[illegible]	-.29	-.28	-.27	-.26	-.23
10.	.05	0.00	-.04	-.06	-.11	-.17	-.20	-.21	-.21	-.23	-.22	-.22	-.20	-.18
15.	.08	.04	0.00	-.04	-.07	-.12	-.15	-.17	-.1[illegible]	-.19	-.18	-.18	-.16	-.15
20.	.12	.07	.04	0.00	-.03	-.08	-.10	-.12	-.1[illegible]	-.14	-.13	-.13	-.12	-.11
25.	.15	.10	.07	.03	0.00	-.04	-.07	-.09	-.0[illegible]	-.11	-.10	-.10	-.09	-.08
30.	.18	.14	.11	.07	.04	0.00	-.03	-.04	-.0[illegible]	-.06	-.06	-.06	-.05	-.04
35.	.20	.16	.13	.09	.06	.02	0.00	-.02	-.0[illegible]	-.04	-.04	-.04	-.03	-.02
40.	.21	.17	.14	.11	.08	.04	.02	0.00	-.0[illegible]	-.02	-.02	-.02	-.02	-.01
45.	.22	.18	.15	.11	.09	.05	.02	.01	0.0[illegible]	-.01	-.01	-.01	-.01	-.00
50.	.23	.19	.16	.12	.10	.06	.04	.02	.01	0.00	-.00	-.00	.00	.01
55.	.23	.19	.16	.12	.10	.06	.04	.02	.01	.00	0.00	-.00	.00	.01
60.	.23	.19	.16	.13	.10	.06	.04	.02	.02	.00	.00	0.00	.00	.01
65.	.23	.19	.16	.12	.10	.06	.03	.02	.01	-.00	-.00	-.01	0.00	.01
70.	.22	.18	.15	.11	.09	.05	.03	.01	.0[illegible]	-.01	-.01	-.01	-.01	0.00

TABLE XII. SUN ANGLE CORRECTION COEFFICIENT TABLES FOR JUNE (MODEL DERIVED CANOPY REFLECTANCE)

ALPHA TABLE
WAVELENGTH= .55

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	1.00	1.11	1.19	1.24	1.25	1.37	1.44	1.46	1.47	1.48	1.44	1.38	1.35	1.25
10.	.90	1.00	1.07	1.11	1.12	1.23	1.30	1.31	1.32	1.33	1.29	1.24	1.21	1.13
15.	.84	.93	1.00	1.04	1.05	1.15	1.21	1.22	1.23	1.25	1.21	1.16	1.13	1.05
20.	.81	.90	.96	1.00	1.01	1.11	1.17	1.18	1.19	1.20	1.16	1.12	1.09	1.01
25.	.80	.89	.96	.99	1.00	1.10	1.16	1.17	1.18	1.19	1.15	1.11	1.08	1.00
30.	.73	.81	.87	.90	.91	1.00	1.05	1.06	1.07	1.08	1.05	1.01	.98	.91
35.	.69	.77	.82	.86	.86	.95	1.00	1.01	1.02	1.03	1.00	.95	.93	.87
40.	.69	.76	.82	.85	.86	.94	.99	1.00	1.01	1.02	.99	.95	.92	.86
45.	.68	.76	.81	.84	.85	.93	.98	.99	1.00	1.01	.98	.94	.92	.85
50.	.67	.75	.80	.83	.84	.92	.97	.98	.99	1.00	.97	.93	.91	.84
55.	.69	.77	.83	.86	.87	.95	1.00	1.01	1.02	1.03	1.00	.96	.93	.87
60.	.73	.81	.86	.90	.90	.99	1.05	1.06	1.06	1.08	1.04	1.00	.98	.91
65.	.74	.83	.89	.92	.93	1.02	1.07	1.08	1.09	1.10	1.07	1.02	1.00	.93
70.	.80	.89	.95	.99	1.00	1.09	1.15	1.16	1.17	1.19	1.15	1.10	1.08	1.00

BETA TABLE
WAVELENGTH= .55

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	0.00	-1.39	-2.32	-2.94	-3.23	-4.09	-4.60	-4.84	-5.03	-5.23	-5.12	-4.95	-4.86	-4.49
10.	1.25	0.00	-.83	-1.40	-1.68	-2.38	-2.79	-3.02	-3.20	-3.38	-3.33	-3.23	-3.18	-2.93
15.	1.95	.78	0.00	-.54	-.81	-1.42	-1.79	-2.01	-2.17	-2.35	-2.32	-2.27	-2.24	-2.06
20.	2.38	1.26	.52	0.00	-.26	-.83	-1.16	-1.37	-1.53	-1.70	-1.70	-1.67	-1.65	-1.51
25.	2.59	1.50	.77	.26	0.00	-.54	-.85	-1.06	-1.22	-1.39	-1.39	-1.38	-1.37	-1.25
30.	2.99	1.93	1.24	.75	.49	0.00	-.29	-.49	-.64	-.80	-.83	-.83	-.84	-.76
35.	3.18	2.15	1.47	.99	.74	.27	0.00	-.21	-.35	-.51	-.54	-.56	-.58	-.51
40.	3.32	2.31	1.64	1.16	.91	.46	.20	0.00	-.15	-.30	-.34	-.37	-.39	-.33
45.	3.42	2.42	1.76	1.29	1.04	.60	.35	.15	0.00	-.15	-.19	-.23	-.25	-.21
50.	3.53	2.53	1.88	1.42	1.16	.74	.50	.30	.15	0.00	-.05	-.09	-.11	-.08
55.	3.56	2.57	1.92	1.46	1.21	.79	.54	.34	.20	.05	0.00	-.04	-.07	-.04
60.	3.59	2.60	1.96	1.49	1.24	.83	.59	.39	.24	.09	.04	0.00	-.03	-.00
65.	3.61	2.63	1.98	1.52	1.27	.86	.62	.42	.27	.12	.07	.03	0.00	.03
70.	3.59	2.61	1.96	1.49	1.24	.83	.59	.39	.24	.09	.04	.00	-.03	0.00

ALPHA TABLE
WAVELENGTH= .65

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	1.00	1.10	1.19	1.23	1.26	1.38	1.46	1.48	1.50	1.53	1.49	1.44	1.42	1.33
10.	.91	1.00	1.08	1.12	1.14	1.25	1.33	1.35	1.36	1.39	1.35	1.30	1.28	1.20
15.	.84	.92	1.00	1.03	1.05	1.16	1.23	1.24	1.26	1.28	1.25	1.21	1.19	1.11
20.	.81	.89	.97	1.00	1.02	1.12	1.19	1.20	1.22	1.24	1.21	1.17	1.15	1.08
25.	.80	.88	.95	.98	1.00	1.10	1.16	1.18	1.19	1.22	1.18	1.14	1.13	1.06
30.	.72	.80	.86	.89	.91	1.00	1.06	1.07	1.03	1.11	1.08	1.04	1.02	.96
35.	.68	.75	.81	.84	.86	.95	1.00	1.01	1.02	1.05	1.02	.98	.97	.91
40.	.67	.74	.80	.83	.85	.93	.99	1.00	1.01	1.03	1.00	.97	.95	.90
45.	.67	.73	.80	.82	.84	.92	.98	.99	1.01	1.02	.99	.96	.94	.89
50.	.65	.72	.78	.81	.82	.90	.96	.97	.90	1.00	.97	.94	.93	.87
55.	.67	.74	.80	.83	.84	.93	.98	1.00	1.0[illegible]	1.03	1.00	.97	.95	.89
60.	.70	.77	.83	.86	.87	.96	1.02	1.03	1.06	1.06	1.03	1.00	.98	.92
65.	.71	.78	.84	.87	.89	.98	1.03	1.05	1.06	1.08	1.05	1.02	1.00	.94
70.	.75	.83	.90	.93	.95	1.04	1.10	1.12	1.13	1.15	1.12	1.08	1.07	1.00

BETA TABLE
WAVELENGTH= .65

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	0.00	-.52	-.93	-1.20	-1.38	-1.79	-2.04	-2.18	-2.28	-2.41	-2.37	-2.31	-2.29	-2.14
10.	.47	0.00	-.37	-.62	-.78	-1.14	-1.35	-1.48	-1.57	-1.69	-1.66	-1.63	-1.62	-1.51
15.	.78	.34	0.00	-.24	-.39	-.71	-.90	-1.02	-1.11	-1.21	-1.20	-1.19	-1.18	-1.10
20.	.98	.56	.23	0.00	-.15	-.44	-.61	-.73	-.81	-.91	-.91	-.90	-.91	-.84
25.	1.09	.69	.37	.14	0.00	-.27	-.44	-.55	-.64	-.73	-.74	-.74	-.74	-.68
30.	1.29	.91	.61	.39	.25	0.00	-.15	-.26	-.34	-.43	-.44	-.45	-.46	-.42
35.	1.39	1.02	.73	.51	.38	.14	0.00	-.11	-.19	-.28	-.29	-.31	-.32	-.28
40.	1.47	1.10	.82	.60	.47	.24	.11	0.00	-.08	-.16	-.18	-.20	-.21	-.19
45.	1.52	1.16	.88	.67	.53	.31	.18	.08	0.00	-.08	-.10	-.13	-.14	-.12
50.	1.57	1.22	.95	.74	.60	.39	.26	.16	.08	0.00	-.02	-.05	-.06	-.05
55.	1.59	1.23	.96	.75	.62	.41	.29	.18	.11	.02	0.00	-.02	-.04	-.02
60.	1.61	1.25	.98	.78	.64	.43	.31	.21	.13	.05	.03	0.00	-.02	-.00
65.	1.62	1.26	1.00	.79	.66	.45	.33	.22	.15	.07	.04	.02	0.00	.01
70.	1.61	1.25	.99	.78	.65	.44	.31	.21	.13	.05	.03	.00	-.01	0.00

ALPHA TABLE
WAVELENGTH= .75

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	1.00	1.12	1.21	1.25	1.26	1.37	1.45	1.53	1.56	1.56	1.53	1.48	1.46	1.38
10.	.89	1.00	1.09	1.11	1.13	1.23	1.30	1.37	1.39	1.40	1.37	1.32	1.31	1.23
15.	.82	.92	1.00	1.03	1.04	1.13	1.20	1.27	1.28	1.29	1.27	1.22	1.20	1.14
20.	.80	.90	.97	1.00	1.02	1.10	1.17	1.23	1.25	1.26	1.23	1.18	1.17	1.11
25.	.79	.88	.96	.99	1.00	1.09	1.15	1.21	1.23	1.24	1.21	1.17	1.16	1.09
30.	.73	.81	.88	.91	.92	1.00	1.06	1.12	1.13	1.14	1.12	1.08	1.06	1.00
35.	.69	.77	.83	.86	.87	.94	1.00	1.06	1.07	1.08	1.06	1.02	1.01	.95
40.	.65	.73	.79	.81	.82	.89	.95	1.00	1.01	1.02	1.00	.96	.95	.90
45.	.64	.72	.78	.80	.81	.88	.93	.99	1.00	1.01	.99	.95	.94	.89
50.	.64	.71	.77	.80	.81	.88	.93	.98	.99	1.00	.98	.94	.93	.88
55.	.65	.73	.79	.81	.82	.89	.95	1.00	1.01	1.02	1.00	.96	.95	.90
60.	.68	.76	.82	.84	.86	.93	.98	1.04	1.05	1.06	1.04	1.00	.99	.93
65.	.68	.77	.83	.85	.87	.94	1.00	1.05	1.06	1.07	1.05	1.01	1.00	.94
70.	.73	.81	.88	.90	.92	1.00	1.05	1.11	1.13	1.14	1.11	1.07	1.06	1.00

BETA TABLE
WAVELENGTH= .75

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	0.00	-.25	-.44	-.57	-.65	-.84	-.97	-1.10	-1.16	-1.20	-1.19	-1.16	-1.15	-1.08
10.	.22	0.00	-.17	-.29	-.37	-.54	-.65	-.77	-.82	-.86	-.86	-.83	-.83	-.78
15.	.36	.16	0.00	-.11	-.19	-.34	-.44	-.54	-.59	-.63	-.64	-.62	-.62	-.58
20.	.45	.26	.11	0.00	-.07	-.21	-.31	-.41	-.45	-.49	-.50	-.49	-.49	-.45
25.	.51	.33	.18	.07	0.00	-.14	-.22	-.32	-.36	-.40	-.41	-.40	-.41	-.37
30.	.61	.44	.30	.19	.12	0.00	-.08	-.17	-.21	-.25	-.26	-.26	-.26	-.24
35.	.67	.55	.37	.26	.19	.08	0.00	-.08	-.12	-.16	-.17	-.18	-.18	-.16
40.	.72	.56	.43	.33	.26	.15	.08	0.00	-.04	-.08	-.09	-.10	-.10	-.09
45.	.75	.59	.46	.36	.29	.18	.12	.04	0.00	-.04	-.05	-.06	-.06	-.05
50.	.77	.61	.49	.39	.33	.22	.15	.08	.04	0.00	-.01	-.02	-.03	-.02
55.	.79	.62	.53	.40	.34	.23	.16	.09	.05	.01	0.00	-.01	-.02	-.01
60.	.78	.63	.51	.41	.34	.24	.17	.10	.06	.02	.01	0.00	-.01	.00
65.	.79	.64	.57	.42	.35	.25	.18	.11	.07	.03	.02	.01	0.00	.01
70.	.78	.63	.51	.41	.34	.24	.17	.10	.06	.02	.01	-.00	-.01	0.00

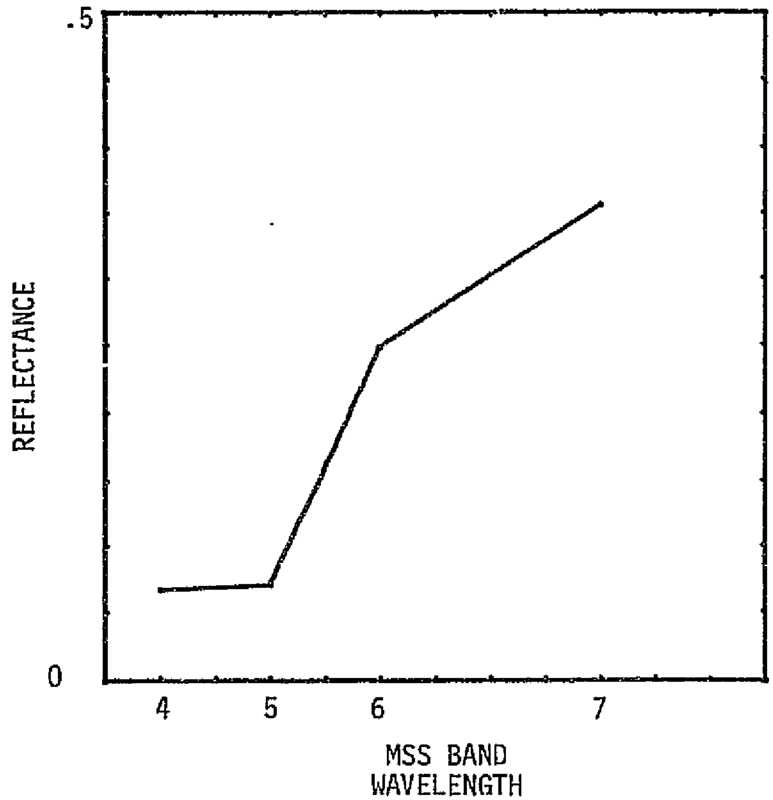
ALPHA TABLE
WAVELENGTH= .95

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	1.00	1.11	1.21	1.24	1.26	1.36	1.44	2.19	1.56	1.56	1.54	1.48	1.47	1.39
10.	.90	1.00	1.08	1.11	1.13	1.22	1.29	1.97	1.41	1.40	1.38	1.33	1.32	1.25
15.	.83	.92	1.00	1.03	1.04	1.13	1.19	1.82	1.25	1.30	1.27	1.22	1.21	1.15
20.	.81	.90	.98	1.00	1.01	1.10	1.16	1.77	1.26	1.26	1.24	1.19	1.18	1.12
25.	.80	.89	.96	.99	1.00	1.08	1.15	1.75	1.24	1.25	1.23	1.18	1.17	1.11
30.	.73	.82	.89	.91	.92	1.00	1.06	1.61	1.14	1.15	1.13	1.08	1.08	1.02
35.	.69	.77	.84	.86	.87	.95	1.00	1.52	1.08	1.09	1.07	1.03	1.02	.96
40.	.46	.51	.55	.56	.57	.62	.66	1.00	.71	.71	.70	.67	.67	.63
45.	.64	.72	.78	.80	.81	.88	.93	1.41	1.00	1.01	.99	.95	.94	.89
50.	.64	.71	.77	.79	.80	.87	.92	1.40	.99	1.00	.98	.94	.94	.89
55.	.65	.72	.78	.80	.82	.88	.94	1.42	1.01	1.02	1.00	.96	.95	.90
60.	.68	.75	.82	.84	.85	.92	.98	1.48	1.05	1.06	1.04	1.00	.99	.94
65.	.68	.76	.82	.85	.86	.93	.98	1.50	1.06	1.07	1.05	1.01	1.00	.95
70.	.72	.80	.87	.89	.90	.98	1.04	1.58	1.12	1.13	1.11	1.06	1.06	1.00

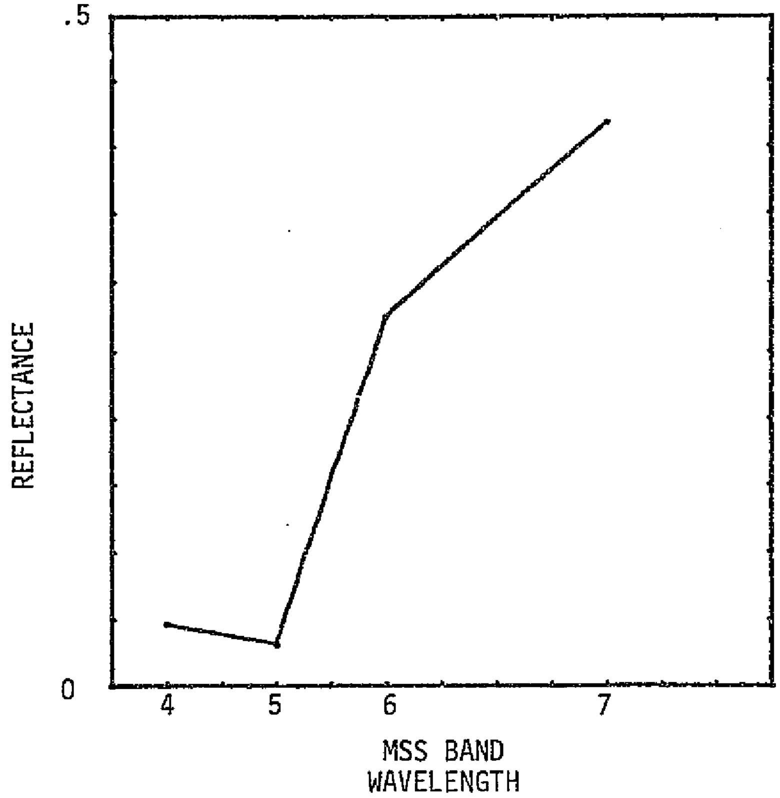
BETA TABLE
WAVELENGTH= .95

	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.	65.	70.
5.	0.00	-.07	-.13	-.17	-.20	-.26	-.31	-.59	-.38	-.39	-.39	-.38	-.37	-.35
10.	.07	0.00	-.05	-.09	-.12	-.17	-.21	-.45	-.28	-.29	-.29	-.28	-.28	-.26
15.	.11	.05	0.00	-.04	-.06	-.11	-.15	-.35	-.21	-.22	-.22	-.21	-.21	-.20
20.	.14	.08	.03	0.00	-.03	-.07	-.11	-.29	-.16	-.18	-.18	-.17	-.17	-.16
25.	.16	.10	.06	.02	0.00	-.05	-.08	-.24	-.13	-.15	-.15	-.14	-.14	-.13
30.	.19	.14	.10	.07	.04	0.00	-.03	-.17	-.08	-.09	-.09	-.09	-.09	-.08
35.	.21	.16	.13	.09	.07	.03	0.00	-.12	-.05	-.06	-.06	-.06	-.06	-.05
40.	.27	.23	.19	.16	.14	.10	.08	0.00	.04	.03	.02	.02	.02	.03
45.	.24	.20	.16	.13	.11	.07	.04	-.06	0.00	-.01	-.02	-.02	-.02	-.01
50.	.25	.21	.17	.14	.12	.08	.05	-.04	.01	0.00	-.00	-.00	-.01	.00
55.	.25	.21	.17	.14	.12	.08	.06	-.03	.02	.00	0.00	-.00	-.00	.00
60.	.25	.21	.18	.14	.12	.08	.06	-.03	.02	.01	.00	0.00	-.00	.01
65.	.25	.21	.18	.14	.12	.08	.06	-.03	.02	.01	.00	.00	0.00	.01
70.	.25	.21	.17	.14	.12	.08	.05	-.04	.01	-.00	-.00	-.01	-.01	0.00

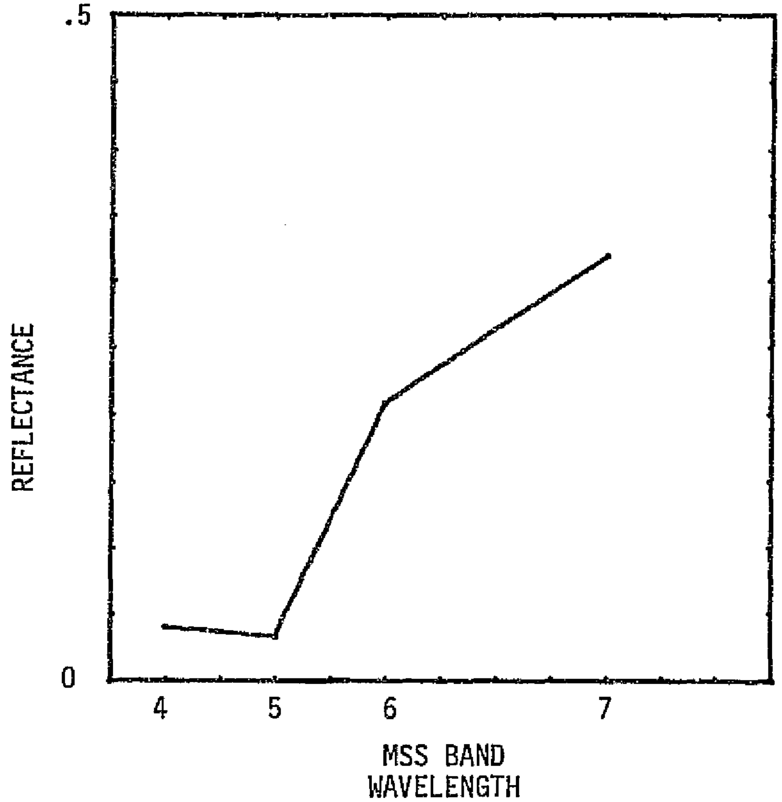
APPENDIX B: VARIATION OF WHEAT CANOPY REFLECTANCE WITH SUN ANGLE (EMPIRICAL DATA)



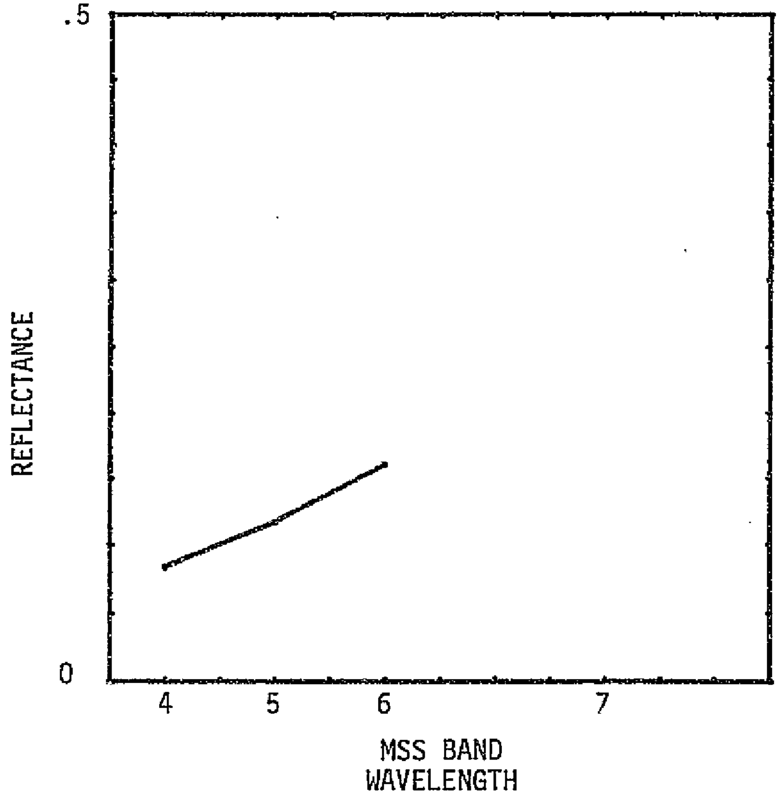
Wheat Canopy Reflectance for March 20 Averaged
Over All Sun Angles and LAI (Empirical Data)



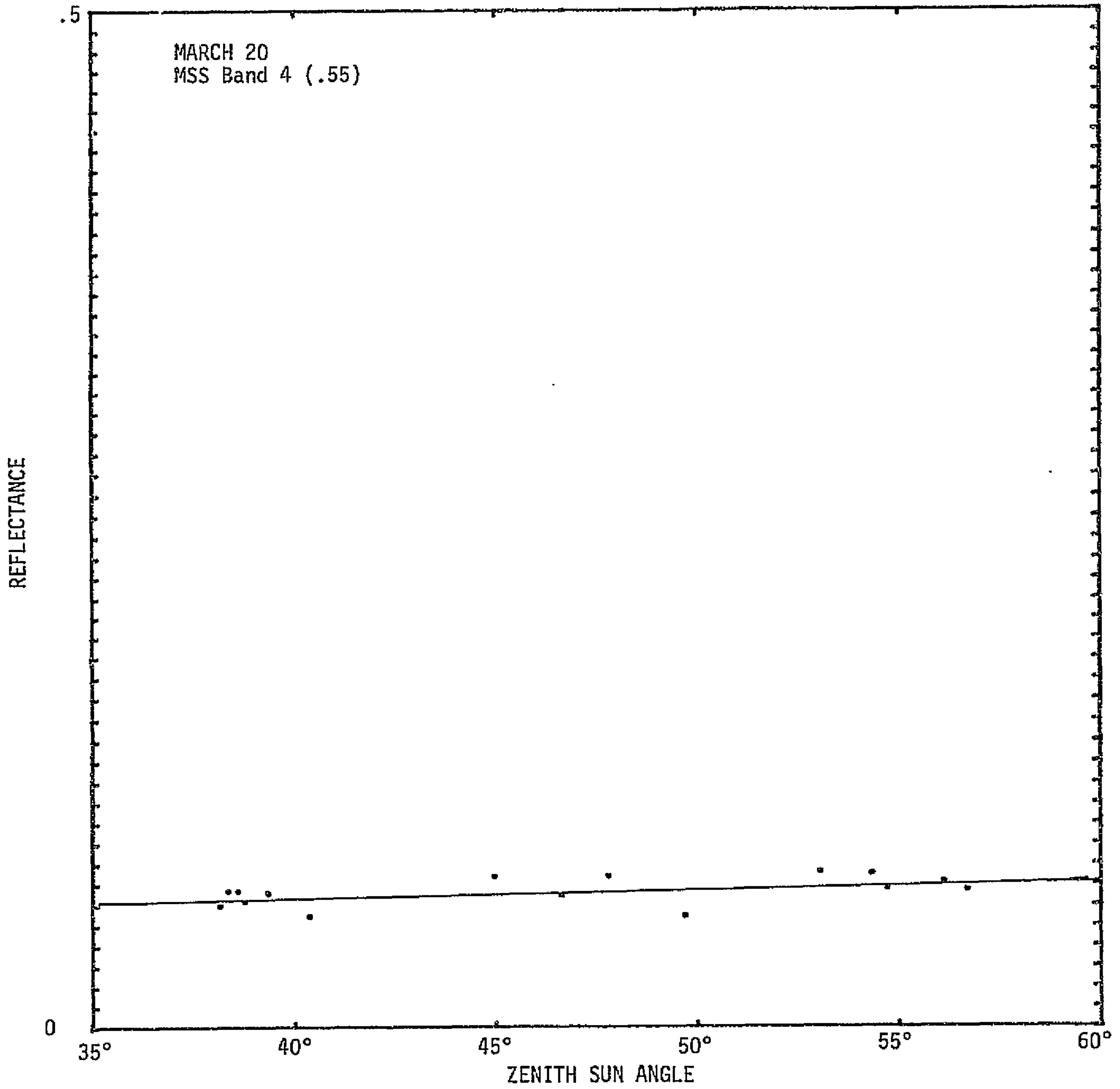
Wheat Canopy Reflecatnce for April 23 Averaged
Over All Sun Angles and LAI (Empirical Data)

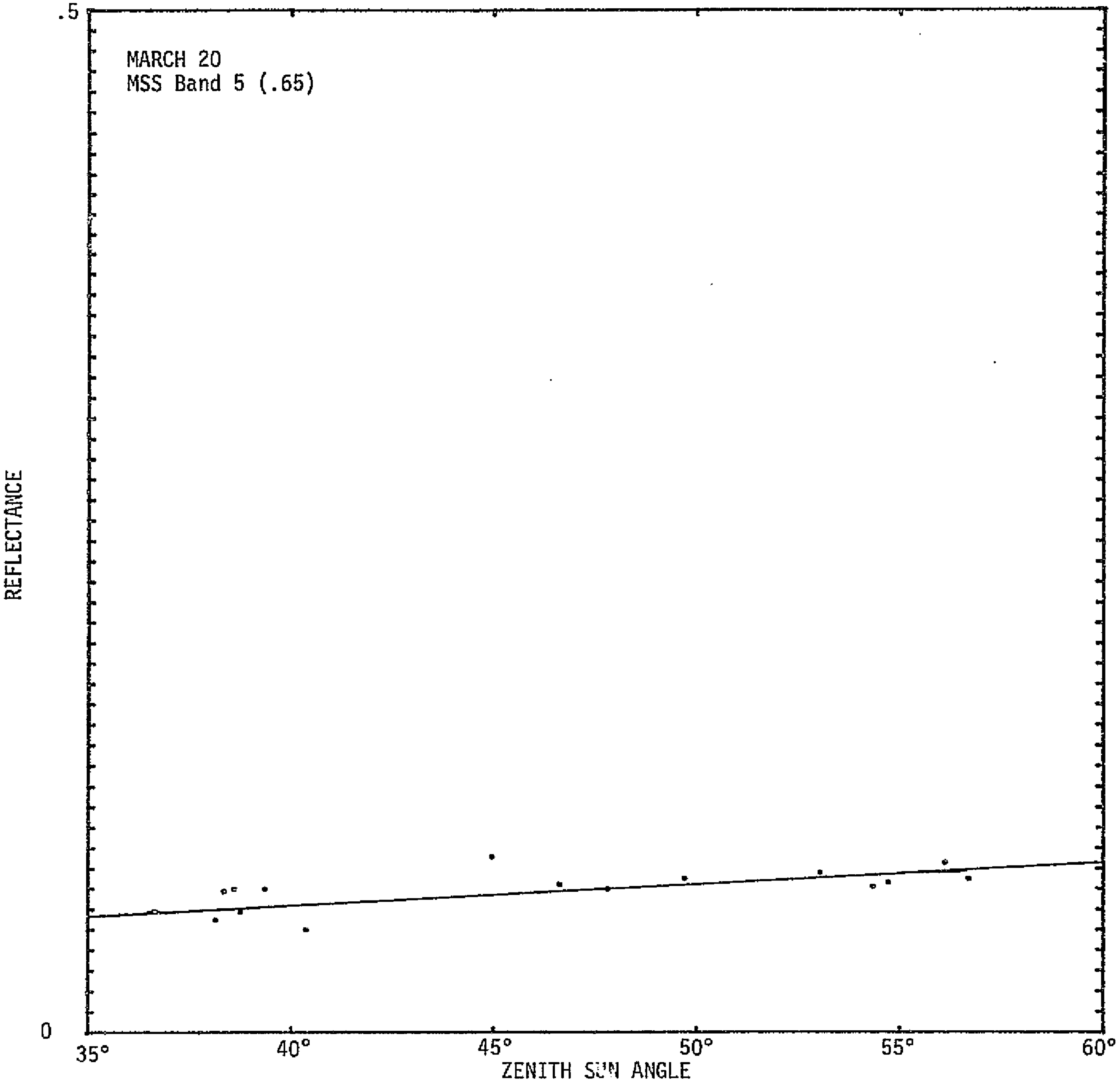


Wheat Canopy Reflectance for May 20 Averaged
Over All Sun Angles and LAI (Empirical Data)

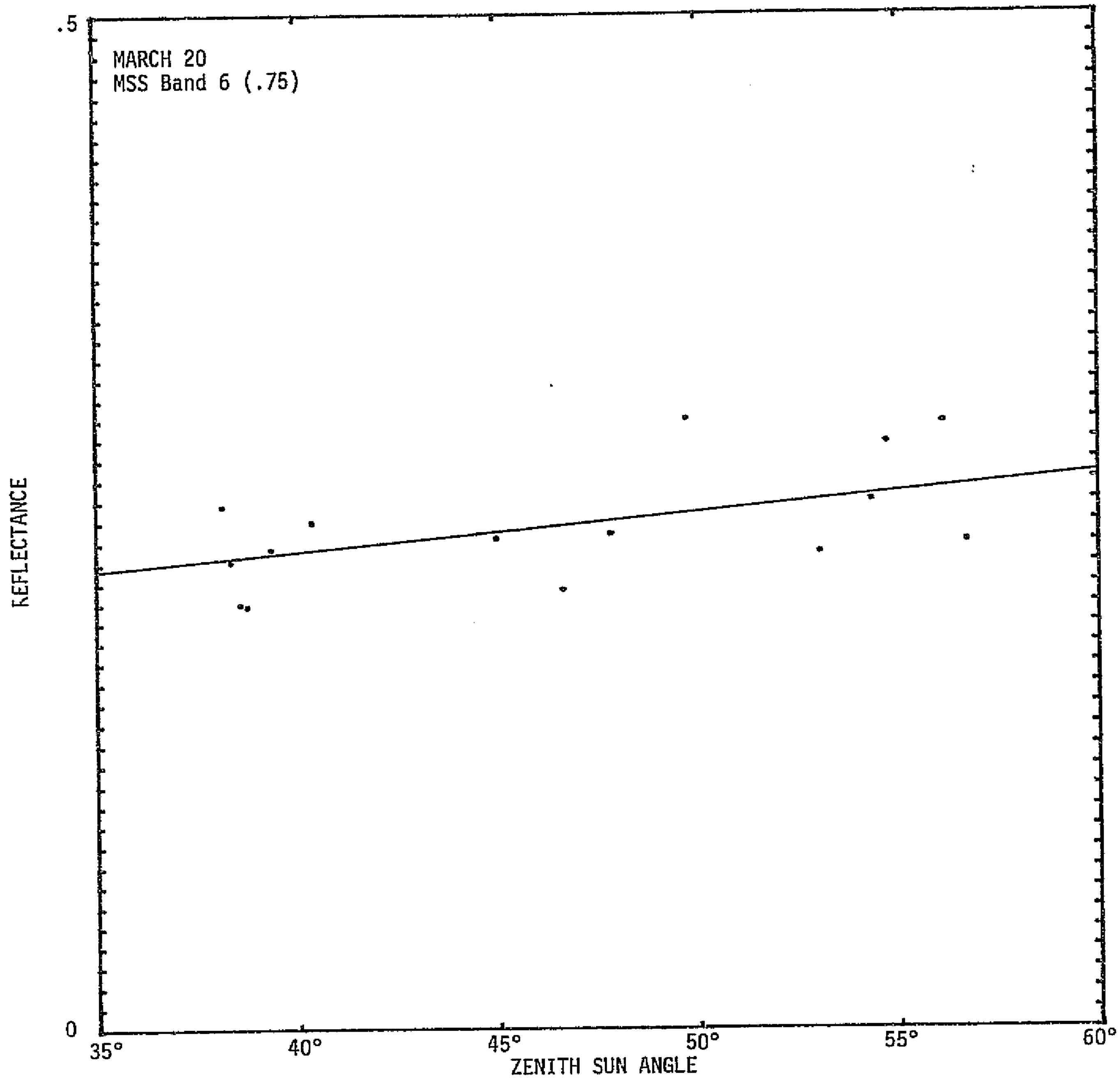


Wheat Canopy Reflectance for June 26 Averaged
Over All Sun Angles and LAI (Empirical Data)

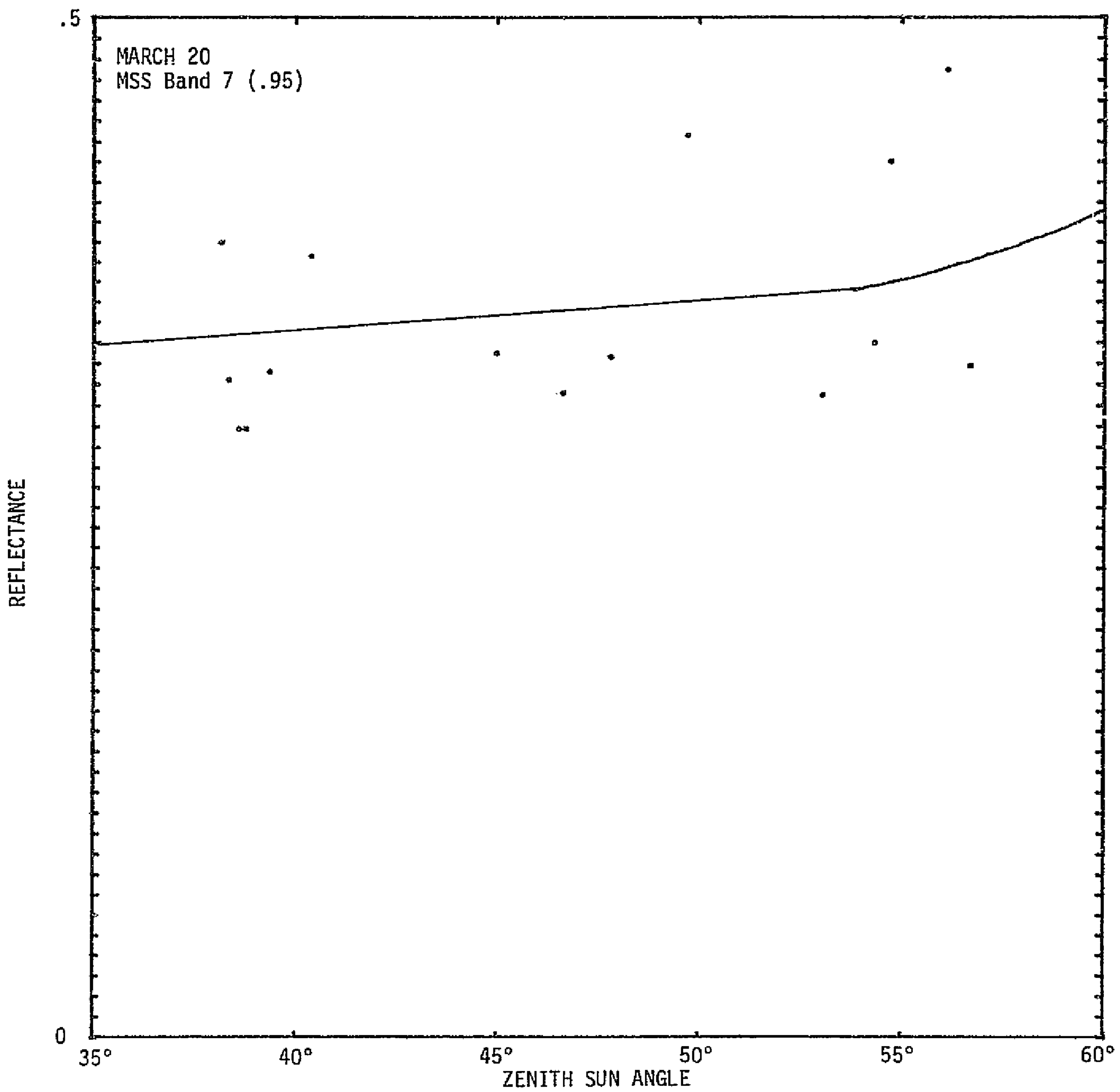

MARCH 20
MSS Band 4 (.55)
.5
0
REFLECTANCE
35°
40°
45°
50°
55°
60°
ZENITH SUN ANGLE



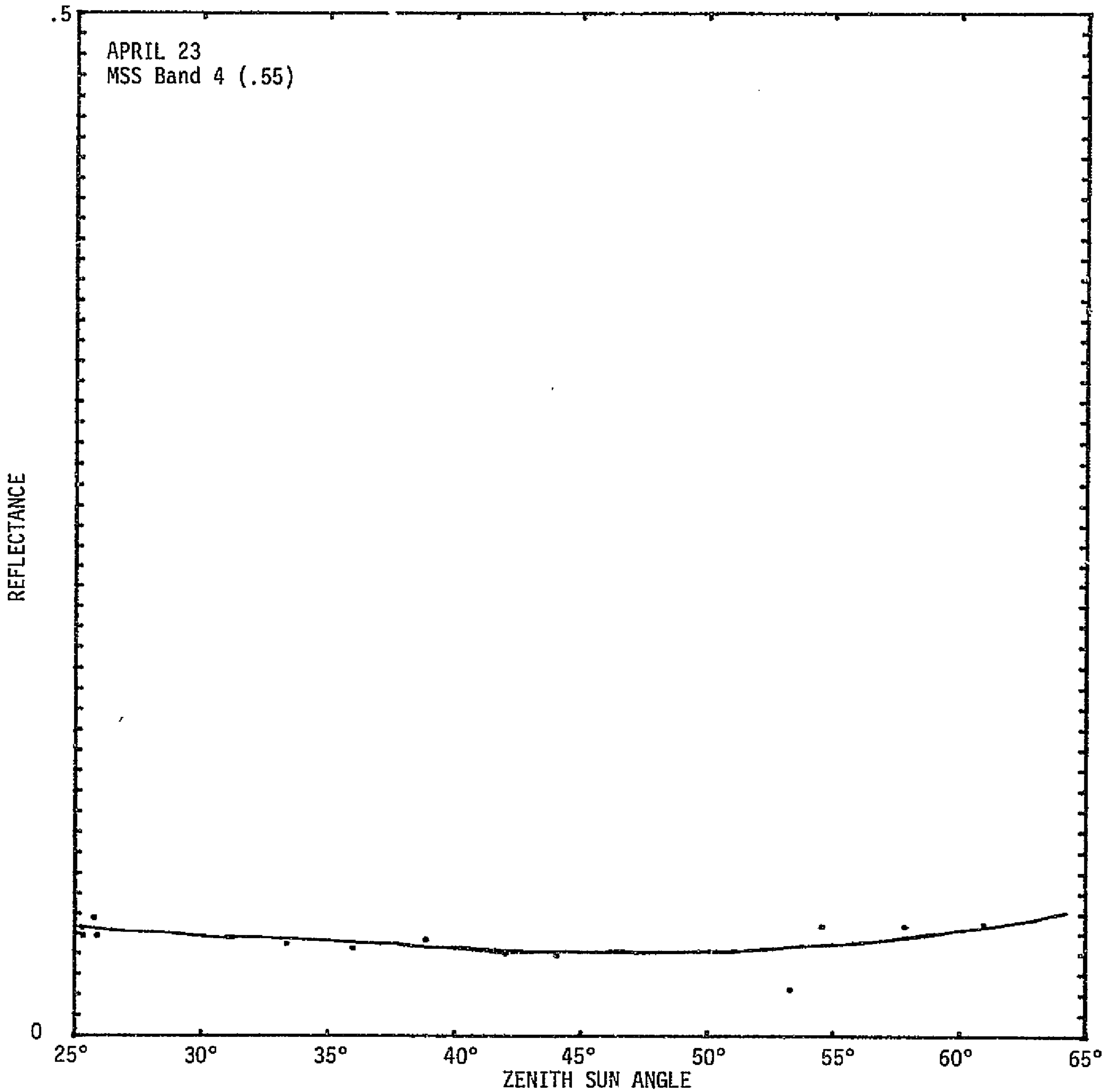
MARCH 20
MSS Band 5 (.65)
.5
0
REFLECTANCE
35°
40°
45°
50°
55°
60°
ZENITH SUN ANGLE

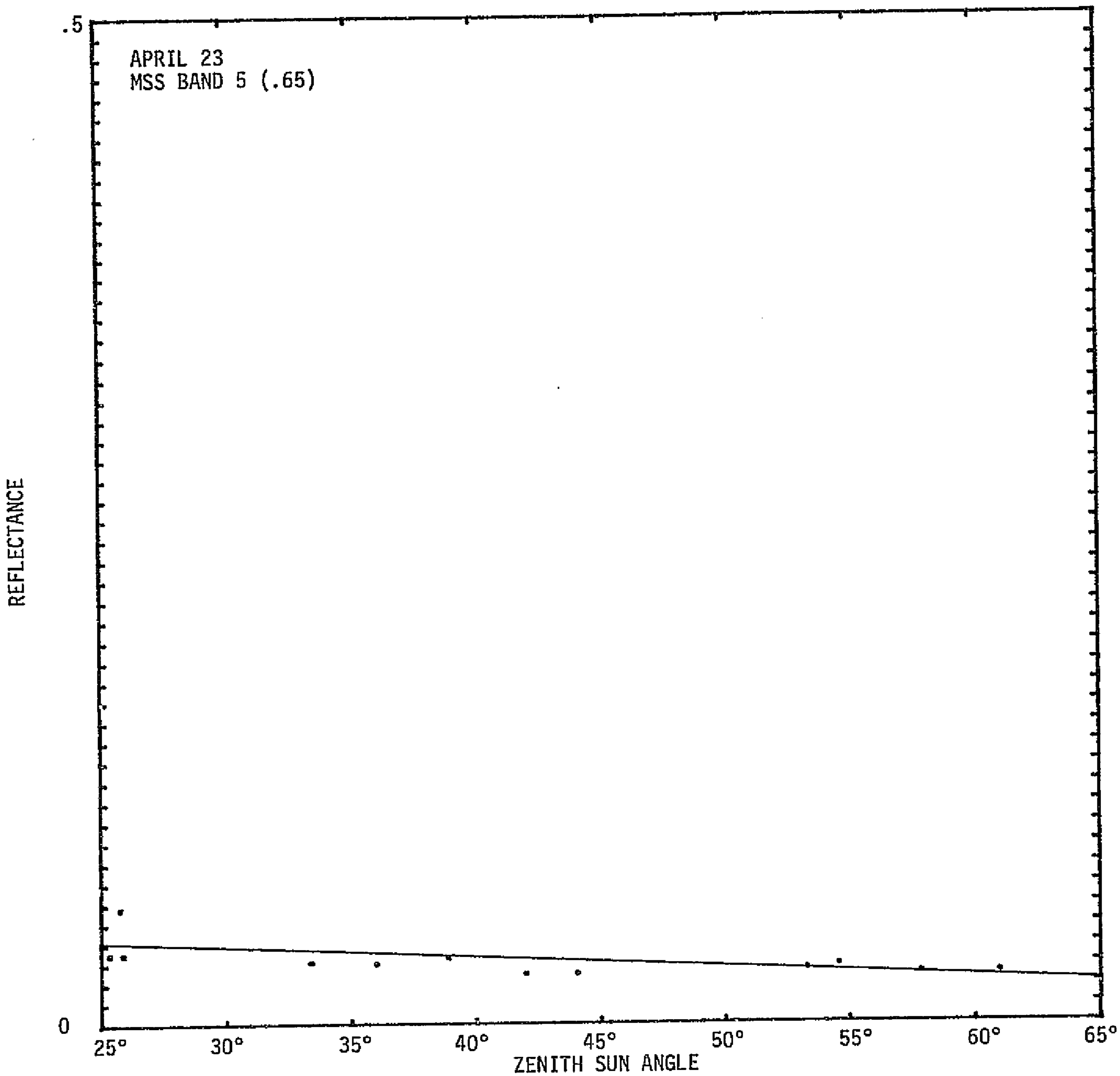


MARCH 20
MSS Band 6 (.75)
.5
0
REFLECTANCE
35°
40°
45°
50°
55°
60°
ZENITH SUN ANGLE

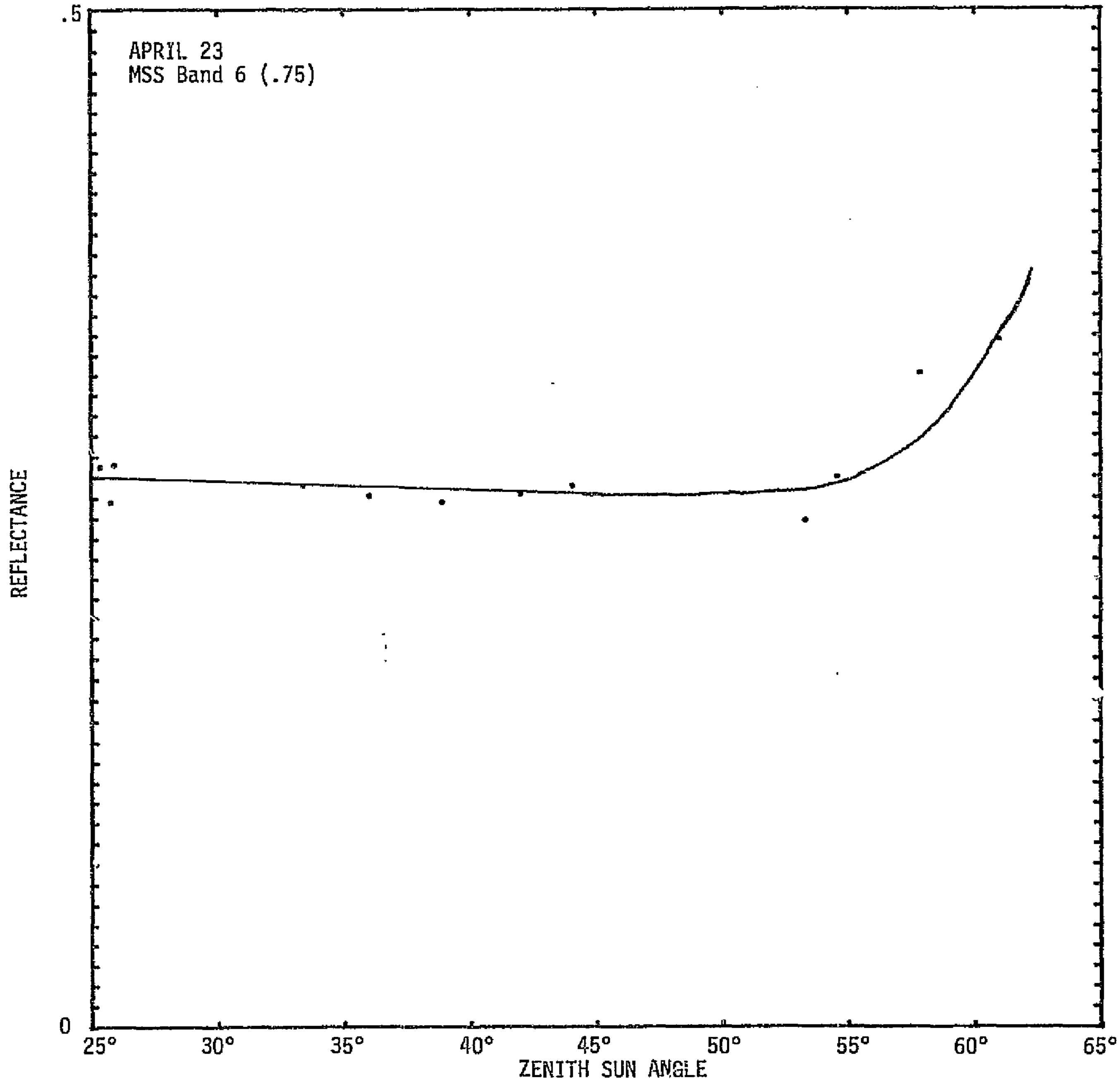


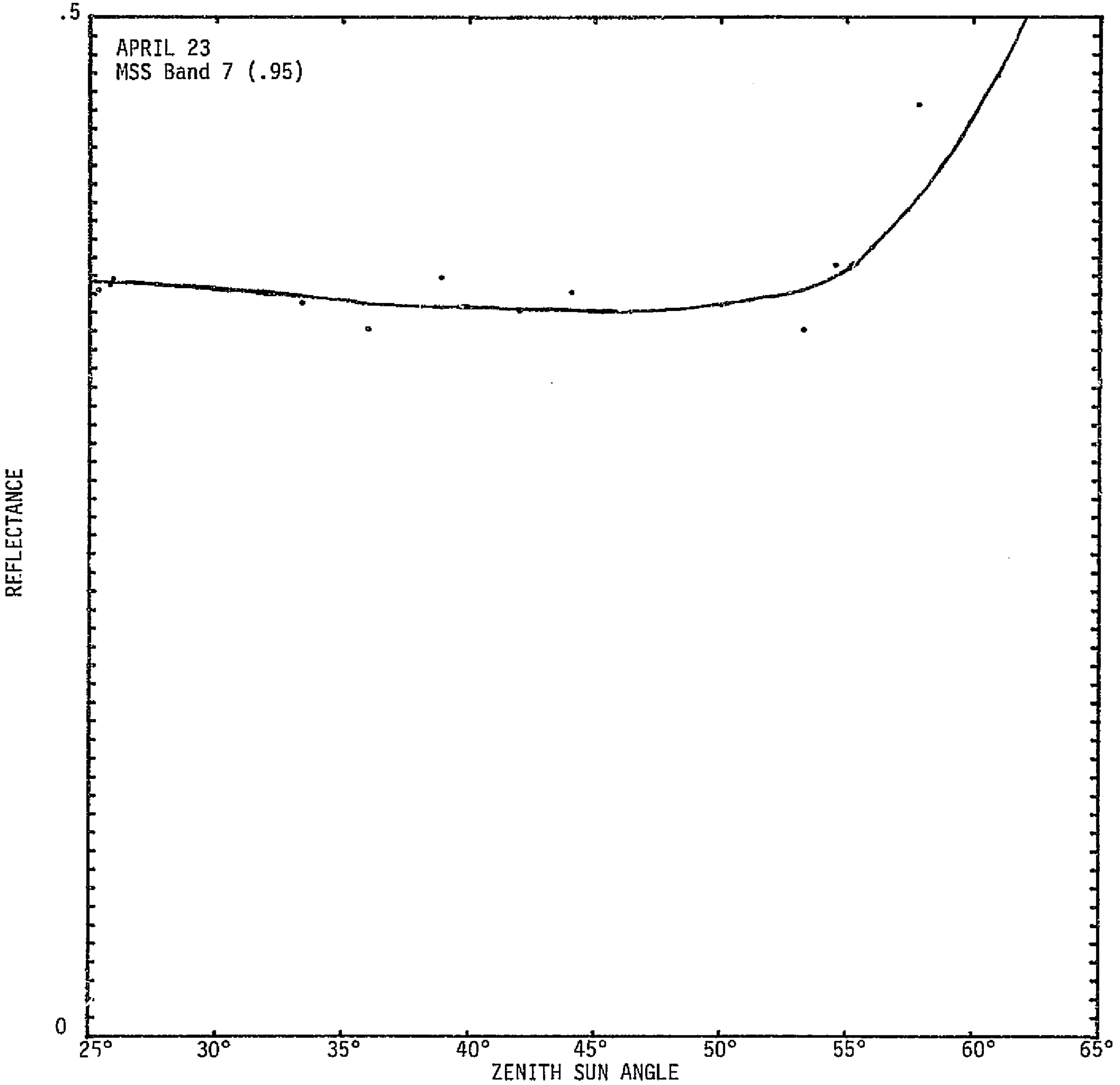
.5
MARCH 20
MSS Band 7 (.95)
REFLECTANCE
0
35°
40°
45°
50°
55°
60°
ZENITH SUN ANGLE


APRIL 23
MSS Band 4 (.55)
REFLECTANCE
.5
0
25°
30°
35°
40°
45°
50°
55°
60°
65°
ZENITH SUN ANGLE



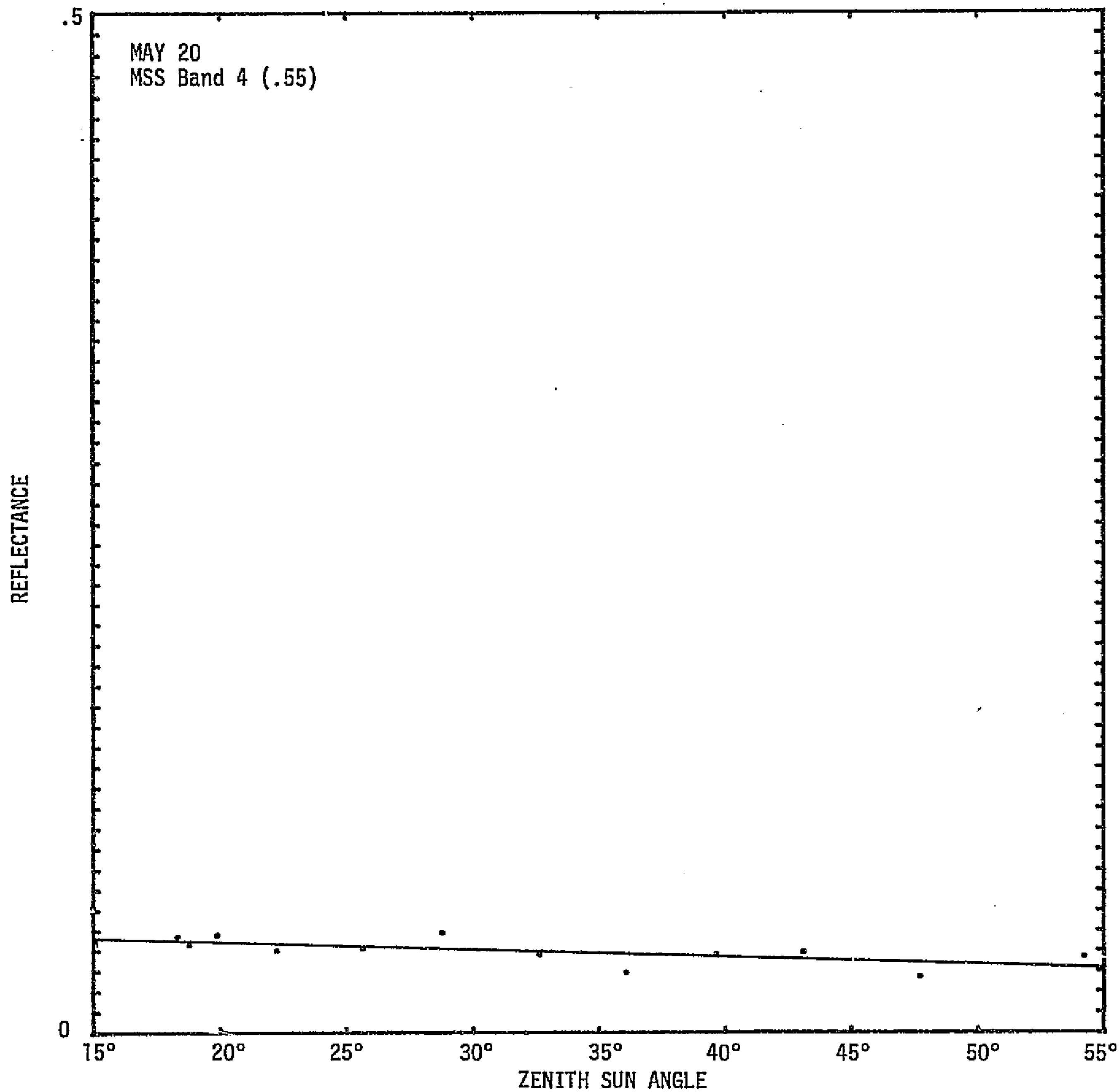
.5
APRIL 23
MSS BAND 5 (.65)
REFLECTANCE
0
25°
30°
35°
40°
45°
50°
55°
60°
65°
ZENITH SUN ANGLE


APRIL 23
MSS Band 6 (.75)
.5
0
REFLECTANCE
25°
30°
35°
40°
45°
50°
55°
60°
65°
ZENITH SUN ANGLE

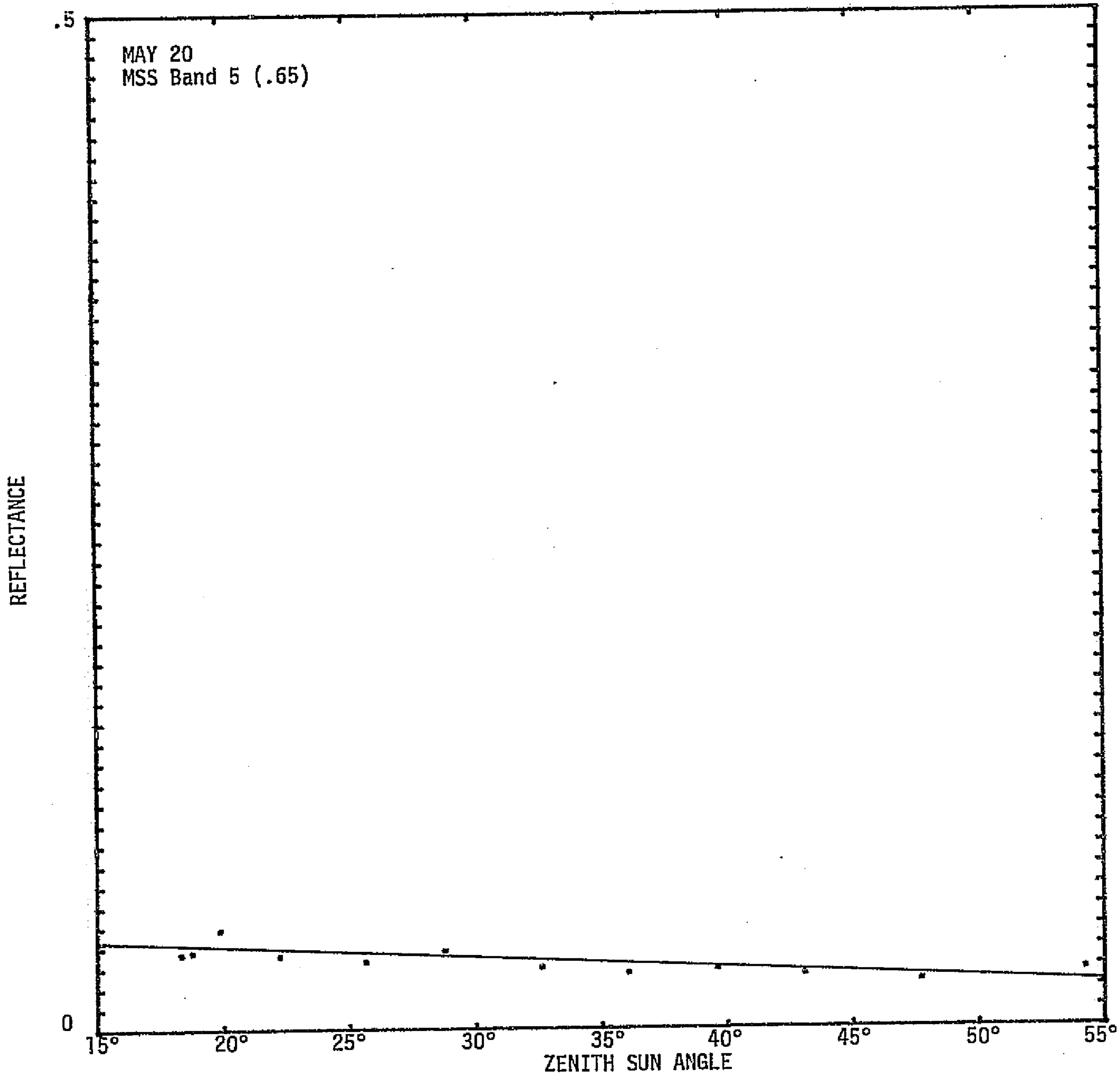

APRIL 23
MSS Band 7 (.95)
.5
0
REFLECTANCE
25°
30°
35°
40°
45°
50°
55°
60°
65°
ZENITH SUN ANGLE

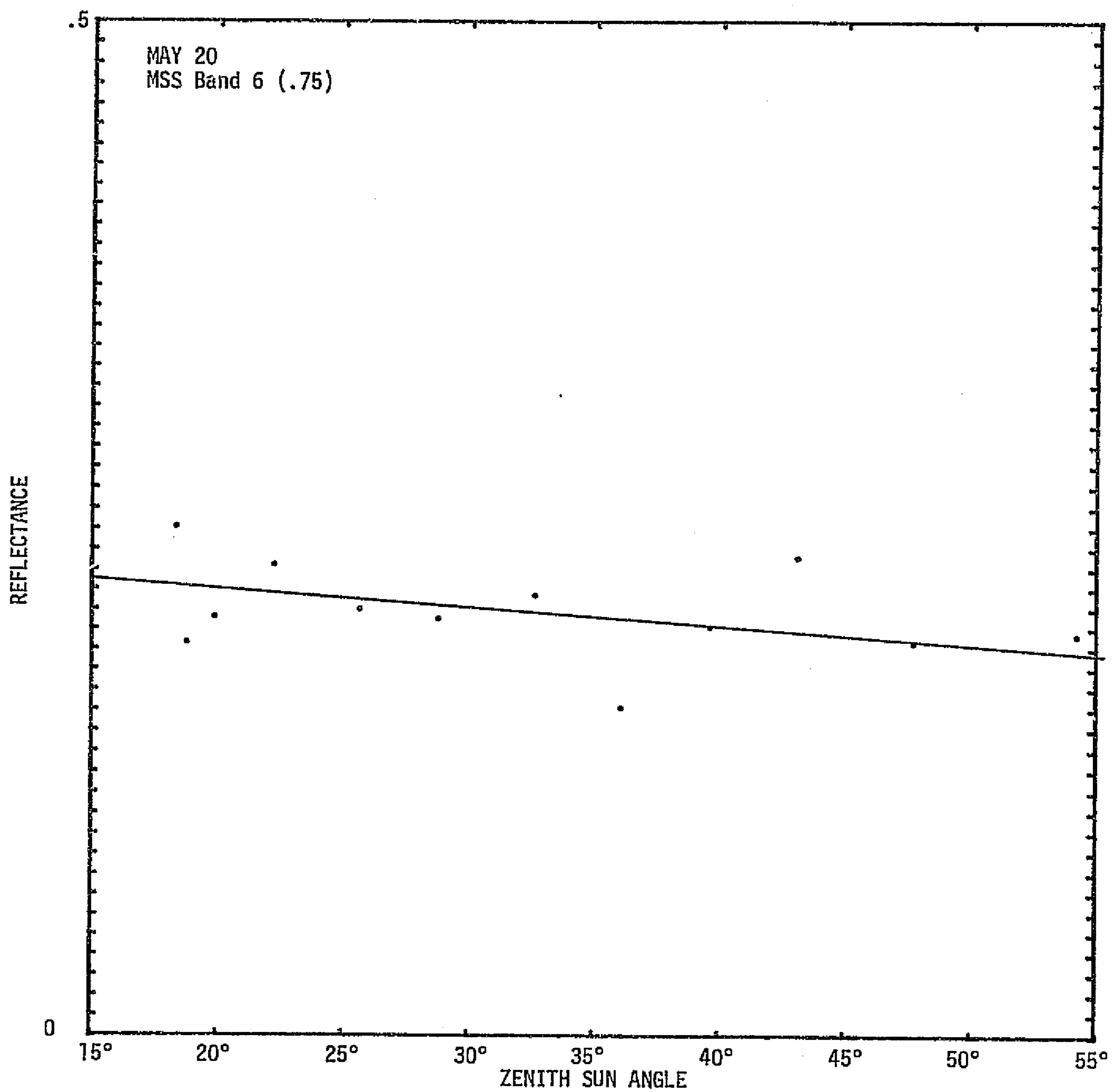
C.2

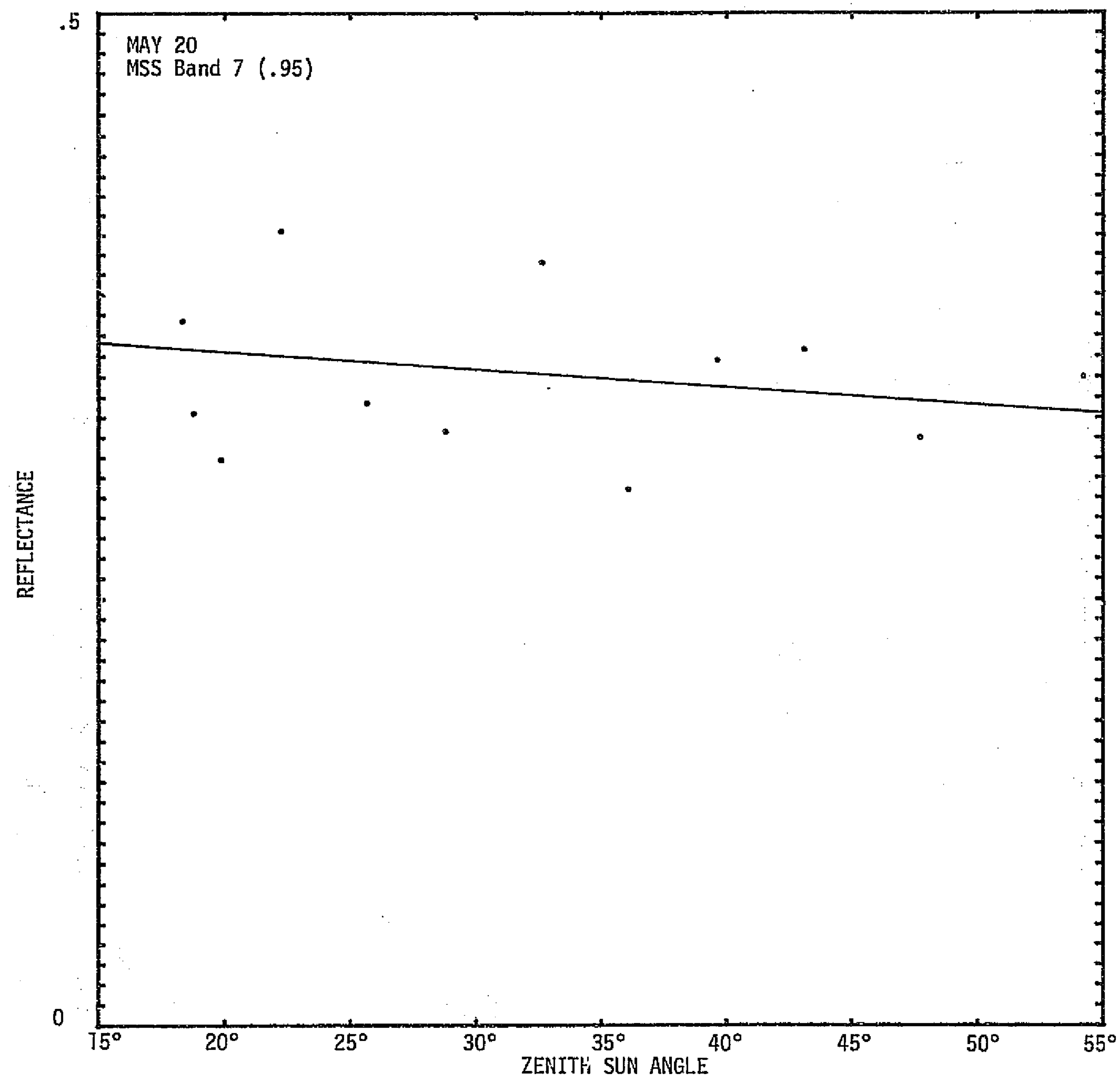
C-2

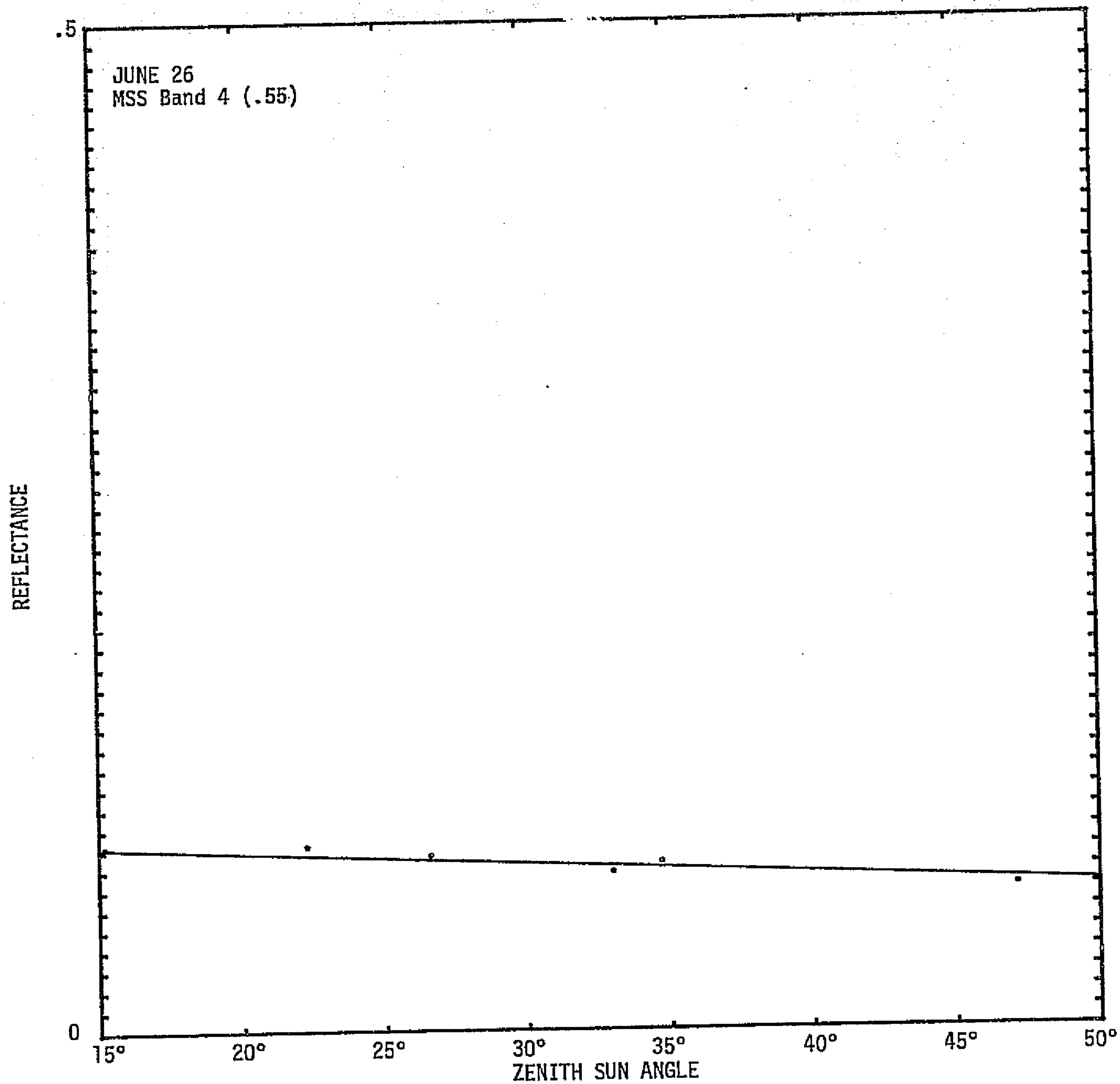


.5
MAY 20
MSS Band 4 (.55)
REFLECTANCE
0
15°
20°
25°
30°
35°
40°
45°
50°
55°
ZENITH SUN ANGLE

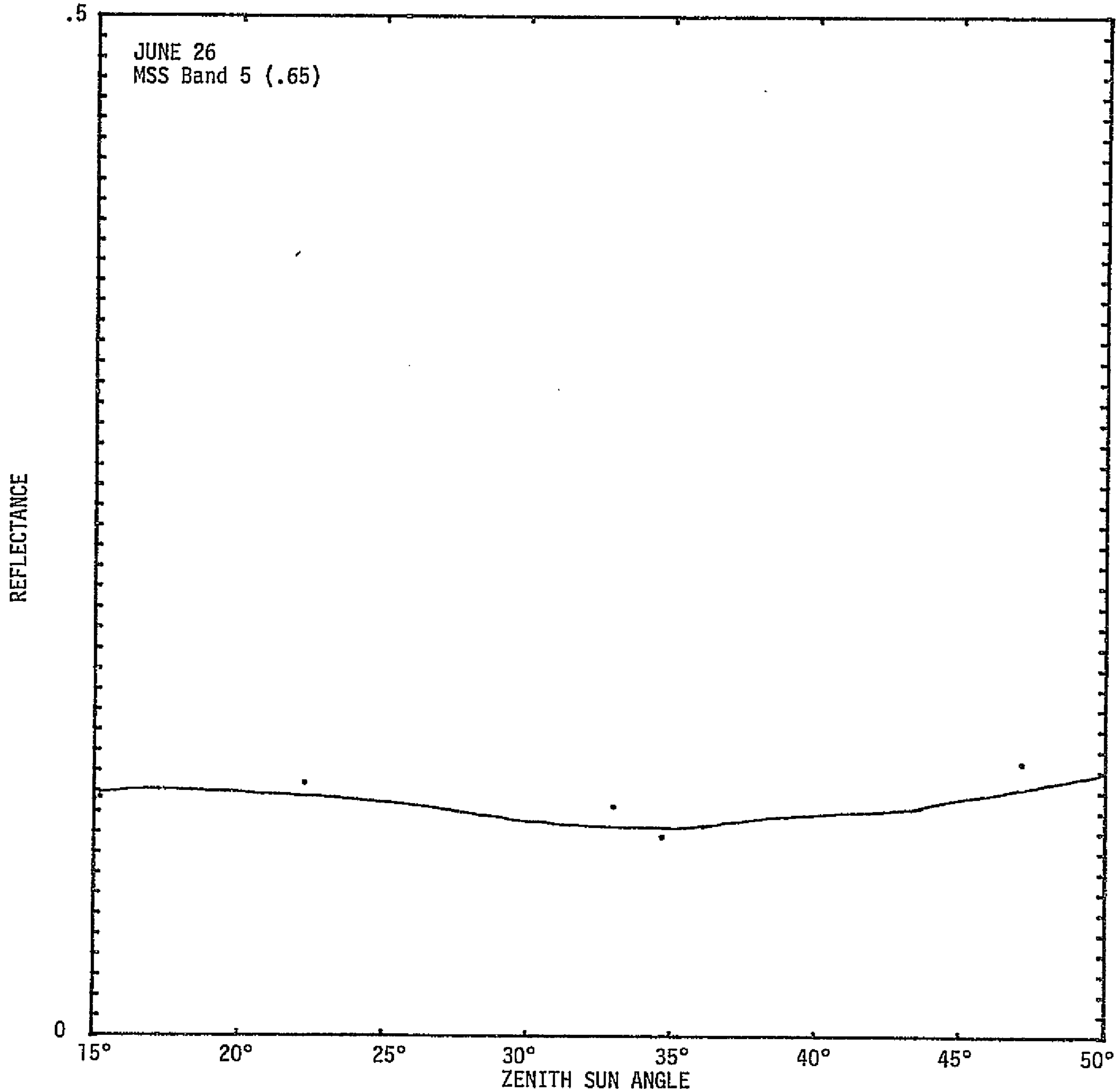

MAY 20
MSS Band 5 (.65)
.5
0
REFLECTANCE
15°
20°
25°
30°
35°
40°
45°
50°
55°
ZENITH SUN ANGLE


MAY 20
MSS Band 6 (.75)
.5
0
REFLECTANCE
15°
20°
25°
30°
35°
40°
45°
50°
55°
ZENITH SUN ANGLE

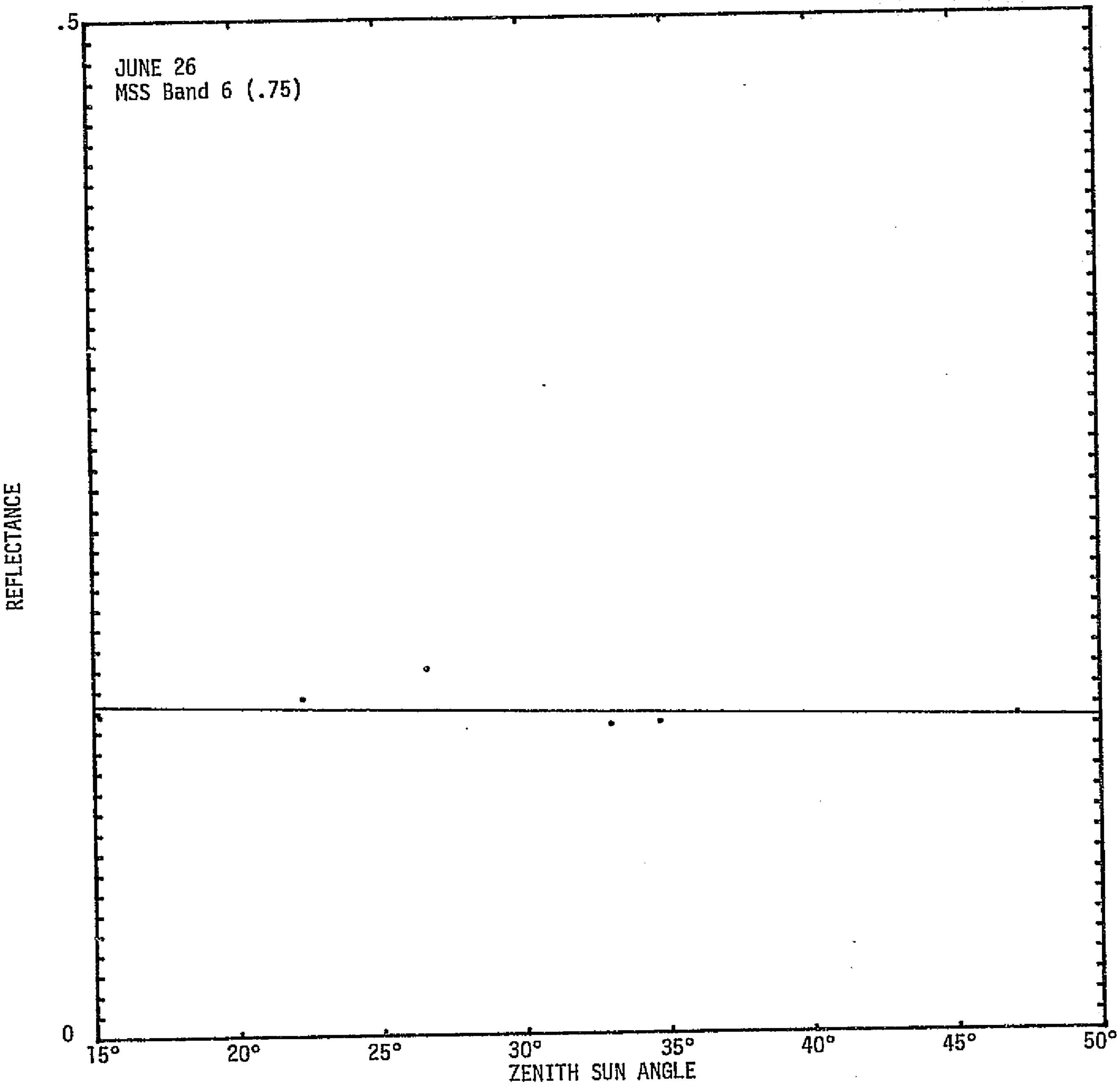

MAY 20
MSS Band 7 (.95)
.5
0
REFLECTANCE
15°
20°
25°
30°
35°
40°
45°
50°
55°
ZENITH SUN ANGLE



JUNE 26
MSS Band 4 (.55)
REFLECTANCE
.5
0
15°
20°
25°
30°
35°
40°
45°
50°
ZENITH SUN ANGLE



JUNE 26
MSS Band 5 (.65)
.5
0
REFLECTANCE
15°
20°
25°
30°
35°
40°
45°
50°
ZENITH SUN ANGLE


JUNE 26
MSS Band 6 (.75)
REFLECTANCE
.5
0
15°
20°
25°
30°
35°
40°
45°
50°
ZENITH SUN ANGLE

APPENDIX C

SUMMARY TABLES FOR SUN ANGLE RELATIONSHIPS

TABLE C.1

EMPIRICAL SUN ANGLE
EFFECTS ON SCENE REFLECTANCE
(For an Average LAI)

SUN ANGLE	MSS4	MSS5	MSS6	MSS7	SUN ANGLE	MSS4	MSS5	MSS6	MSS7
March					April				
38°Z	.062	.059	.209	.299	25°Z	.049	.035	.275	.402
39	.067	.070	.210	.299	36	.043	.030	.261	.381
47	.065	.072	.217	.316	44	.039	.025	.266	.401
53	.076	.078	.235	.315	58	.054	.025	.321	.503
57	.067	.075	.240	.329					
May					June				
19°Z	.043	.038	.193	.302	15°Z	.092	.117	.158	--
26	.041	.033	.210	.307	22	.092	.124	.166	--
36	.029	.027	.161	.264	27	.087	.116	.180	--
48	.027	.023	.193	.290	35	.083	.098	.153	--

TABLE C.2

MARCH

SUN ∡	4	5	6	7
5°Z	.028	.022	.136	.189
10	.029	.022	.142	.198
15	.030	.022	.148	.206
20	.033	.025	.165	.229
25	.036	.027	.182	.251
30	.039	.029	.196	.269
35	.041	.031	.210	.287
40	.044	.033	.225	.307
45	.047	.035	.239	.327
50	.049	.035	.257	.352
55	.053	.038	.279	.383
60	.065	.047	.343	.467
65	.073	.052	.393	.534
70	.084	.060	.452	.614

APRIL

SUN ∡	4	5	6	7
5°Z	.031	.021	.164	.230
10	.033	.023	.177	.246
15	.035	.024	.189	.262
20	.038	.026	.204	.282
25	.041	.028	.218	.302
30	.042	.029	.226	.314
35	.043	.030	.233	.325
40	.048	.034	.258	.359
45	.053	.037	.283	.392
50	.054	.038	.292	.405
55	.059	.041	.318	.440
60	.065	.045	.349	.483
65	.074	.052	.402	.555
70	.085	.061	.467	.644

MAY

5°Z	.023	.016	.125	.177
10	.024	.017	.133	.188
15	.025	.018	.141	.198
20	.028	.020	.152	.214
25	.030	.021	.163	.229
30	.033	.024	.183	.256
35	.037	.026	.202	.282
40	.039	.028	.215	.299
45	.041	.029	.227	.316
50	.046	.033	.252	.349
55	.050	.036	.273	.377
60	.056	.040	.305	.420
65	.064	.046	.348	.477
70	.076	.054	.409	.558

JUNE

5°Z	.048	.052	.100	.118
10	.054	.058	.113	.133
15	.059	.064	.125	.147
20	.063	.068	.132	.155
25	.066	.072	.139	.163
30	.076	.083	.158	.185
35	.085	.093	.177	.207
40	.092	.101	.200	.336
45	.101	.111	.220	.259
50	.113	.125	.244	.287
55	.124	.137	.269	.317
60	.138	.153	.298	.350
65	.162	.180	.351	.412
70	.191	.212	.413	.485

TABLE C.3

MODEL GENERATED SUN ANGLE
EFFECTS ON SATELLITE SENSED
TOTAL RADIANCE
(Milliwatts/Square Centimeter/Steradian/Micrometer)

SUN ANGLE	MSS4	MSS5	MSS6	MSS7	SUN ANGLE	MSS4	MSS5	MSS6	MSS7
MARCH					APRIL				
5°Z	5.901	3.032	6.029	5.166	5°Z	5.991	2.991	7.014	6.145
10	5.053	2.715	6.055	5.271	10	5.230	2.756	7.273	6.481
15	4.456	2.512	6.028	5.314	15	4.716	2.552	7.462	6.739
20	4.123	2.372	6.323	5.656	20	4.375	2.411	7.619	6.927
25	3.950	2.290	6.569	5.907	25	4.153	2.328	7.691	7.045
30	3.699	2.164	6.619	5.987	30	3.815	2.164	7.507	6.924
35	3.517	2.053	6.614	5.995	35	3.590	2.019	7.280	6.741
40	3.324	1.949	6.915	5.953	40	3.460	1.981	7.430	6.895
45	3.129	1.858	6.372	5.819	45	3.315	1.916	7.445	6.915
50	2.907	1.694	6.166	5.662	50	3.048	1.773	6.936	6.484
55	2.754	1.616	5.946	5.473	55	2.903	1.685	6.712	6.276
60	2.724	1.628	6.320	5.834	60	2.724	1.588	6.408	6.006
65	2.588	1.548	6.129	5.664	65	2.606	1.548	6.292	5.892
70	2.721	1.659	7.154	6.649	70	2.454	1.471	5.993	5.631
MAY					JUNE				
5°Z	5.589	2.743	5.397	4.653	5°Z	6.708	4.233	4.521	3.215
10	4.744	2.470	5.500	4.836	10	6.072	4.148	4.807	3.510
15	4.197	2.272	5.586	4.959	15	5.672	4.148	4.807	3.510
20	3.870	2.139	5.726	5.171	20	5.347	4.011	5.064	3.813
25	3.667	2.028	5.833	5.306	25	5.129	3.945	5.068	3.841
30	3.429	1.949	6.130	5.625	30	5.095	4.067	5.367	4.117
35	3.335	1.884	6.325	5.834	35	5.090	4.155	5.603	4.327
40	3.121	1.792	6.239	5.764	40	4.926	4.610	5.700	4.449
45	2.942	1.684	6.048	5.610	45	4.756	4.013	5.700	4.466
50	2.823	1.641	6.052	5.615	50	4.660	3.988	5.714	4.481
55	2.679	1.569	5.825	5.388	55	4.505	3.910	5.704	4.532
60	2.532	1.487	5.654	5.245	60	4.386	3.879	5.689	4.523
65	2.428	1.430	5.451	5.063	65	4.221	3.754	5.554	4.434
70	2.286	1.364	5.197	4.844	70	4.000	3.610	5.375	4.302

APPENDIX D

SUMMARY TABLES FOR LEAF-AREA-INDEX RELATIONSHIPS

TABLE D.1

EMPIRICAL LAI EFFECTS REFLECTANCE DATA AT SURFACE
(Standard Deviations Shown in Parentheses)

DATE	LAI	MSS4	MSS5	MSS6	MSS7
MARCH					
	1.31	.07100 (±.002)	.07675 (.005)	.29775 .021)	.47500 (.029)
	2.07	.07625 (.002)	.07800 (.002)	.23475 (.016)	.31975 (.019)
	4.06	.07975 (.002)	.07125 (.006)	.26000 (.012)	.34000 (.023)
APRIL					
	5.13	.04100 (.006)	.0265 (.007)	.26225 (.015)	.38050 (.023)
	5.36	.03925 (.001)	.02475 (.001)	.26600 (.021)	.40125 (.048)
	6.15	.03975 (.007)	.02475 (.005)	.26150 (.044)	.39125 (.054)

TABLE D.2

MODEL LAI EFFECTS REFLECTANCE
DATA AT SURFACE (UNSMOOTHED)

DATE	LAI	MSS4	MSS5	MSS6	MSS7	MSS7/5
MARCH						
	0.5	.0432	.0450	.1490	.2002	4.449
	1.0	.0524	.0450	.2386	.3257	7.238
	1.5	.0470	.0369	.2334	.3198	8.667
	2.0	.0535	.0418	.2642	.3607	8.629
	2.5	.0487	.0352	.2574	.3528	10.023
	3.0	.0532	.0381	.2788	.3801	9.976
	3.5	.0537	.0385	.2820	.3845	9.987
	4.0	.0538	.0378	.2853	.3889	10.288
	4.5	.0562	.0395	.2972	.4045	10.241
	5.0	.0562	.0395	.2974	.4051	10.256
APRIL						
	3.5	.0504	.0351	.2694	.3728	10.621
	4.0	.0508	.0354	.2721	.3781	10.681
	4.5	.0519	.0362	.2773	.3845	10.622
	5.0	.0496	.0345	.2663	.3711	10.757
	5.5	.0511	.0356	.2734	.3786	10.635
	6.0	.0506	.0352	.2708	.3750	10.653
	6.5	.0503	.0350	.2691	.3726	10.646
	7.0	.0494	.0344	.2638	.3647	10.602
	7.5	.0494	.0343	.2636	.3645	10.627
	8.0	.0494	.0343	.2636	.3645	10.627

TABLE D.3

MODEL LAI EFFECTS RADIANCE
DATA AT SATELLITE (SMOOTHED)
(Milliwatts/Square Centimeter/Steradian/Micrometer)

DATE	LAI	MSS4	MSS5	MSS6	MSS7	MSS7/5
MARCH						
	0.5	2.699	1.922	3.659	3.208	1.670
	1.0	2.951	1.922	5.630	5.137	2.672
	1.5	2.803	1.714	5.515	5.046	2.944
	2.0	2.982	1.840	6.196	5.678	3.086
	2.5	2.850	1.670	6.046	5.556	3.327
	3.0	2.973	1.745	6.519	5.978	3.426
	3.5	2.987	1.755	6.590	6.046	3.445
	4.0	2.990	1.768	6.664	6.114	3.862
	4.5	3.056	1.781	6.928	6.355	3.568
	5.0	3.056	1.781	6.932	6.365	3.574
APRIL						
	3.5	3.455	1.986	7.595	7.049	3.549
	4.0	3.469	1.995	7.668	7.147	3.582
	4.5	3.505	2.020	7.807	7.266	3.597
	5.0	3.429	1.967	7.513	7.017	3.567
	5.5	3.479	2.001	7.702	7.157	3.577
	6.0	3.462	1.989	7.633	7.090	3.565
	6.5	3.452	1.983	7.587	7.045	3.553
	7.0	3.422	1.964	7.446	6.898	3.512
	7.5	3.422	1.961	7.441	6.894	3.516
	8.0	3.422	1.961	7.441	6.894	3.516